INSECTS OF HAWAII

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A Manual of the Insects of the Hawaiian Islands, including an Enumeration of the Species and Notes on their Origin, Distribution, Hosts, Parasites, etc.

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VOLUME 10

DIPTERA: NEMATOCERA—BRACHYCERA

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U P H

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PREFACE TO VOLUME 10

This first volume on the Diptera of Hawaii has resulted from about eight years of concerted work by myself with a great deal of help from others. Most of the field work has been done during the summer seasons when I was free from teaching duties at the University and except for infrequent trips made throughout the year on Oahu, no opportunity has been had to do year-around sampling of the Diptera fauna. From the information gained on Oahu it is obvious that flies become much more scarce during our cooler, wetter, winter months but it is suspected that there probably are comparatively few of our species which are actually restricted to either the summer or the winter seasons.

The writing of this volume has occupied the bulk of my research time for approximately three years. Some very cumbersome problems have presented themselves and due to our meager knowledge of some of the groups I have had to attempt to survey the available world literature in order that I might gain an understanding of our somewhat heterogeneous fauna. I realize fully well the fact that many errors have probably been made due to my inadequate knowledge and for any such mistakes or any omissions I accept full responsibility.

This first volume treats 147 species and 5 subspecies of Diptera. These belong in 14 families, 67 genera, and 17 subgenera.

This work has been made possible through a grant from the National Science Foundation. Without this financial assistance I could not have completed this study.

Since the above manuscript has been finished and placed in the editor's hands I feel that I have made a mistake in reverting to the Meigen 1803 names for the Hawaiian Diptera. This is a complete reversal of my previous stand and I have not been following this concept in my other current works on the flies. This has been a long-term project, however, and while working in England in 1954 I became convinced from my conversations with the Secretary of the International Commission and with entomologists that the Commission was "soon" to take action on the Meigen question and that the 1800 names were to be invalidated. I began this series with the conviction that by the time the works appeared in press the matter would be resolved and the 1803 names would again be acceptable to all workers. At this late date, however, it seems that the matter is no nearer solution than it was when I began and the confusion of names must go on and on.

I am much dissatisfied with my attempted historical treatment of the supergeneric names. This has been a very time-consuming and rather thankless task and since I have not had access to adequate library facilities my treatment is obviously preliminary. Since completion of this manuscript I have learned that C. F. Sabrosky of the U. S. National Museum has been preparing a paper on the

supergeneric names throughout the Diptera. This will be an extremely useful piece of work and will completely supplant my preliminary efforts in this area.

In preparing these volumes on the flies I have been dependent on the help of specialists in the many groups with which I have been dealing and to many other entomologists for aid in searching out references in literature not available here in the State of Hawaii.

The dipterists at the U. S. National Museum, the British Museum (Natural History), and the Commonwealth Institute of Entomology have been especially helpful; I am much indebted to the following specialists at these institutions: Alan Stone, W. W. Wirth, R. H. Foote, C. W. Sabrosky, and P. H. Arnaud, Jr., (U. S. National Museum); Harold Oldroyd, Paul Freeman, and P. F. Mattingly (British Museum); and the late F. I. Van Emden (Commonwealth Institute). These workers have given me much assistance in working out taxonomic and nomenclatorial problems and have been most generous in lending me materials for study and in making all of the necessary facilities available to me during the periods which I spent doing research on the Hawaiian Diptera at the British Museum and the U. S. National Museum.

Many thanks are due to other entomologists who have contributed much to this study: C. P. Alexander and F. R. Shaw, University of Massachusetts; Edwin F. Cook and C. E. Mickel, University of Minnesota; A. E. Pritchard, University of California; J. L. Laffoon, Iowa State College; M. T. James, Washington State College; K. E. Frick, Prosser, Washington; S. S. Roback, Philadelphia Academy of Natural Sciences; L. W. Quate, B. P. Bishop Museum; H. R. Dodge, U.S.D.A., Forest Insect Laboratory, Missoula, Montana; H. H. Smith, University of Idaho; M. R. Wheeler, University of Texas; A. L. Melander, Riverside, California; J. F. McAlpine, Canada Department of Agriculture, Ottawa; H. Dietrich, Cornell University; C. N. Colyer, Upton by Chester, England; J. E. Collin, Newmarket, England; D. G. Harnden, University of Edinburgh; A. Collart, Institut Royal des Sciences Naturelles de Belgique; John Smart, Cambridge University, England; H. F. Barnes, Harpenden, England; H. Schmitz, Bad Godesberg, Germany; T. Borgmeier, Petropolis, Brazil; R. Frey, Helsinki, Finland; G. H. Satchell, Dunedin, New Zealand; S. J. Paramonov, Canberra, Australia; Lars Brundin, Stockholm, Sweden, S. L. Tuxen, Universitetets Zoologiske Museum, Copenhagen, Denmark and R. Tuomikoski, Helsinki, Finland.

I also am much indebted to the local entomologists for the cooperation, assistance, and encouragement they have given me during this study. Thanks are especially due to L. D. Tuthill, University of Hawaii, for his guidance and advice in working out nomenclatorial and editorial problems and to the following for the part they played in helping with the field work: J. W. Beardsley, Hawaiian Sugar Planters' Association; C. R. Joyce, U. S. Public Health Service; Marian Adachi Kohn, Ryoji Namba, and M. Tamashiro, University of Hawaii; W. C. Mitchell, U. S. Department of Agriculture; C. J. Davis and N. L. H. Krauss, State Board of Agriculture and Forestry; C. P. Hoyt, South Pacific Commission, Noumea, New Caledonia and Carl Isenberg, graduate student, University of Hawaii.

I am most grateful to workers who preceded me. Much of the background information has come from the pioneer studies of R. C. L. Perkins, F. X. Williams, O. Swezey, and E. H. Bryan, Jr.

For the art work I am indebted to Marian Adachi Kohn, formerly of the University of Hawaii, who prepared the great bulk of the drawings, and to Arthur Smith, British Museum (Natural History), who prepared most of the whole drawings. These well-prepared drawings should prove to be the most valuable part of this work.

D. Elmo Hardy

Honolulu, Hawaii

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INSECTS OF HAWAII

CHECKLIST OF THE INSECTS IN THIS VOLUME

Order **DIPTERA**

Suborder NEMATOCERA

Family TIPULIDAE

Subfamily LIMONIINAE

Tribe ERIOPTERINI

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Genus **ERIOPTERA** Meigen							
Subgenus **Meterioptera** Alexander							
bicornifer Alexander	×	*	*	*	×	*	E. Asia
Subgenus **Trimicra** Osten Sacken							
pilipes Fabricius	×	*	*	*	×	×	N. America, Africa, Europe, Middle East
Genus **GONOMYIA** Meigen							
Subgenus **Lipophleps** Bergroth							
hawaiiensis Alexander	*	×	*	*	×	*	
molokaiensis Hardy			×				
Genus **STYRINGOMYIA** Loew							
didyma Grimshaw	×	×	*	*	×	*	Australasia, Pacific
Tribe LIMONIINI							
Genus **LIMONIA** Meigen							
Subgenus **Dicranomyia** Stephens							
grimshawi (Alexander)	×	×		×	×	×	
hawaiiensis (Grimshaw)	×	×	×	×	×	×	
iniquispina Hardy		×	×				
jacobus (Alexander)		×			×	×	
kauaiensis (Grimshaw)	×	×	×	×	×	×	
kauaiensis haleakalae Alexander		×					
kraussi Alexander		×	×				
nigropolita (Alexander)	×	×	×	×	×	×	
stygipennis (Alexander)	×	×	×		×	×	
swezeyi (Alexander)	×	×	×		×	×	
variabilis (Grimshaw)	×	×			×		
variabilis bryani (Alexander)	×						
Subgenus **Geranomyia** Haliday							
advena Alexander					×	×	
Subgenus **Libnotes** Westwood							
perkinsi (Grimshaw)	×	×	×	×	×	×	Marquesas, Society Is., Fiji, Samoa
Family PSYCHOPIDAE							
Subfamily PSYCHODINAE							
Genus **TELMATOSCOPUS** Eaton							
albipunctatus (Williston)	×	×	×	×	×	×	
Genus **PSYCHODA** Latreille							
alternata Say	×	×	*	*	×	×	Cosmopolitan
hardyi Quate	×	×	*	*	×	×	
harrisi Satchell	×	×	*	*	×	*	Australia, Tasmania
inornata Grimshaw	×	×	*	*	×	*	N. America, Canada, Alaska

*Probably present

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
insulicola Quate					×		S. U.S.
pseudalternata Williams	*	*	*	*	×	*	Australia, New Zealand
rarotongensis Satchell	×	*	*	*	×	×	Soc. Is., Cook Is., S. U.S., W. Indies, Alg., Transv'l
salicornia Quate					×		California
uncinula Quate	×	×			×		
williamsi Quate	×	×			×		
wirthi Quate	×	×			×		
Subfamily TRICHOMYIINAE							
Genus **TRICHOMYIA** Curtis							
hawaiiensis Quate	×	×					
oahuensis Quate					×		
Family CULICIDAE							
Subfamily CULICINAE							
Genus **AEDES** Meigen							
aegypti (Linnaeus)	×	×	×	×	×	×	Warm temperate, Tropics, Subtropics
albopictus (Skuse)	×	×	×	×	×	×	Pacific, Oriental & African Tropical
Genus **CULEX** Linnaeus							
quinquefasciatus Say	×	×	×	×	×	×	Warm temperate, Tropics, Subtropics
Subfamily TOXORHYNCHITINAE							
Genus **TOXORHYNCHITES** Theobald							
brevipalpis Theobald	*	*	*		×	*	Africa
splendens (Wiedemann)	*	*	*		×	×	SW Pacific, SE Asia
Family CHIRONOMIDAE							
Subfamily CHIRONOMINAE							
Genus **CALOPSECTRA** Kieffer							
Subgenus **Micropsectra** Kieffer							
bryanti, n. sp.		×					
hawaiiensis n. sp.	×	×			×	×	
hawaiiensis albifasciata n. subsp.		×				×	
kaalae n. sp.					×		
kaalae monticola n. subsp.				×			
lacteiclavus (Grimshaw)						×	
lacteiclavus latifasciata n. subsp.	×						
Genus **CHIRONOMUS** Meigen							
esakii Tokunaga	×		×		×		Mariana Is.
hawaiiensis Grimshaw	×	×	×	×	×	×	
pauciplumatus n. sp.	×		×				
Genus **POLYPEDILUM** Kieffer							
novemmaculatum n. sp.					×		

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Subfamily TANYPODINAE							
Genus **PENTANEURA** Philippi							
planensis Johannsen					×		
Subfamily CORYNONEURINAE							
Genus **CORYNONEURA** Winnertz							
sp. ?						×	
Subfamily ORTHOCLADIINAE							
Genus **CRICOTOPUS** van der Wulp							
bicinctus (Meigen)	*	*	*	*	×	×	E. U.S., Europe, Japan
Genus **METRIOCNEMUS** van der Wulp							
herbicolus n. sp.					×		
Genus **ORTHOCLADIUS** van der Wulp							
Subgenus **Orthocladius** van der Wulp							
davisi n. sp.	×	×					
grimshawi n. sp.	*	×			*	*	
membranisensoria n. sp.	×						
williamsi n. sp.	×					×	
Subgenus **Smittia** Holmgren							
campestris n. sp.					×		
kauaiensis n. sp.						×	
maculiventris (Edwards)	×				×	×	
mauiensis n. sp.		×					
oahuensis n. sp.					×		
paraconjunctus n. sp.					×		
wirthi n. sp.	×				×		
Subfamily CLUNIONINAE							
Genus **CLUNIO** Haliday							
brevis Stone and Wirth					×		
littoralis Stone and Wirth	×				×	×	Midway?
tsushimensis Tokunaga					×		Japan
vagans Stone and Wirth	×				×	×	
Genus **TELMATOGETON** Schiner							
abnormis (Terry)					×	×	
fluviatilis Wirth					×		
hirtus Wirth						×	
japonicus Tokunaga	×						Japan
pacificus Tokunaga	×	*	*	*	×	×	Japan
torrenticola (Terry)	×	×	×				
williamsi Wirth					×		
Genus **THALASSOMYA** Schiner							
setosipennis Wirth	×	×			×	×	
Family CERATOPOGONIDAE							
Subfamily FORCIPOMYIINAE							
Genus **FORCIPOMYIA** Meigen							
Subgenus **Metaforcipomyia** Saunders							
fuscimaculata n. sp.					×		

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Subgenus **Proforcipomyia** Saunders							
ingrami Carter	×	×	×	×	×	×	W. Africa, Pac., Indones., Malaya, Br. W. Indies
palikuensis n. sp.		×					
Subgenus **Trichohelea** Goetghebuer							
brevis (Johannsen)	*	*	*	×	×	*	
Subfamily DASYHELEINAE							
Genus **DASYHELEA** Kieffer							
calvescens Macfie	*	*	*	*	×	×	
hawaiiensis Macfie	×	*	*	*	×	*	
platychaeta n. sp.					×		
Family SCATOPSIDAE							
Genus **HOLOPLAGIA** Enderlein							
guamensis (Johannsen)	*	*	*	*	×	*	Mariana Is., Caroline Is., Panama, W. Africa
Genus **PSECTROSCIARA** Kieffer							
brevicornis Johannsen	*	×	*	*	×	*	
Genus **RHEGMOCLEMINA** Enderlein							
parvula Hardy					×		Caroline Is.
Genus **SCATOPSE** Geoffroy							
fuscipes Meigen	×	*	*	*	×	*	
Family MYCETOPHILIDAE							
Genus **ORFELIA** A. Costa							
Subgenus **Trigemma n. sub. gen.**							
infurcata n. sp.		×	×			×	
Subgenus **Tylparua** Edwards							
cratericola n. sp.		×					
fuscocostata (Grimshaw)	×	×	×			×	
hawaiiensis (Grimshaw)	×	×	×			×	
insularis (Grimshaw)	×	×	×	×	×	×	
Family SCIARIDAE							
Genus **HYPERLASION** Schmitz							
magnisensoria (Hardy)	×	×	×	×	×	×	
Genus **PLASTOSCIARA** Berg							
Subgenus **Cosmosciara** Frey							
adrostylata Hardy	×	*	*	*	×	*	
brevicalcarata Hardy					×		
longicosta Hardy		×			×	×	
Subgenus **Plastosciara** Berg							
latipons Hardy					×		Eniwetok, Marshall Is.
Genus **SCIARA** Meigen							
Subgenus **Leptosciara** Frey							
hawaiiensis Hardy	×	×	×	×	×	×	
Subgenus **Lycoriella** Frey							
garretti Shaw	×	×	*	*	×	×	Eniwetok, Marshall Is.
hardyi Shaw	×	×	×	*	×	×	
hoyti Hardy	×						

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
latistylata Hardy					×		
molokaiensis Grimshaw	×	×	×	×	×	×	
prominens Hardy	×				×		
radicum Brunetti					×		India, Fiji, Samoa, Marquesas, England
solispina Hardy	×						
spatitergum Hardy	×	×	×	*	×	*	
Genus **SCATOPSCIARA** Edwards							
Subgenus **Uddmaniella** Frey							
nigrita Hardy	×				×		
Genus **SPATHOBDELLA** Frey							
setigera n. sp.	×						
Family CECIDOMYIIDAE							
Subfamily LESTREMIINAE							
Tribe LESTREMIINI							
Genus **ANARETE** Haliday							
johnsoni (Felt)	*	×	*	*	×	×	N. U.S., Europe
Genus **LESTREMIA** Macquart							
cinerea Macquart	*	*	*	*	×	*	N. America, Europe
clivicola n. sp.		×					
leucophaea (Meigen)	*	*	*	*	×	*	N. & W. U.S., Australia?, N. Zealand?
palikuensis n. sp.		×					
Tribe MICROMYINI							
Genus **MONARDIA** Kieffer							
recondita n. sp.	×				×		
Genus **MYCOPHILA** Felt							
fungicola Felt					×		California
Subfamily CECIDOMYIINAE							
Tribe BRACHYNEURINI							
Genus **BRACHYNEURA** Rondani							
sp.? (near **eupatorii** Felt)					×		
Genus **OLIGARCES** Meinert							
sp.? (near **ulmi** Felt)					×		
Tribe CONTARINIINI							
Genus **CONTARINIA** Rondani							
maculipennis Felt	×	×	*	*	×	*	
sorghicola (Coquillett)	*	×	*	*	×	*	SE United States
Genus **HETEROCONTARINIA n.gen.**							
spinosa n. sp.					×		
Tribe OLIGOTROPHINI							
Genus **DIARTHRONOMYIA** Felt							
chrysanthemi Ahlberg	×				×		
Genus **MAYETIOLA** Kieffer							
kaalae n. sp.					×		
Genus **PHAENOLAUTHIA** Kieffer							
sp.?					×		

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Tribe EPIDOSEINI							
Genus **JOHNSONOMYIA** Felt							
sp.?					×		
Genus **PORRICONDYLA** Rondani							
sp.?	×				×		
Tribe CECIDOMYIINI							
Genus **ARTHROCNODAX** Rübsaamen							
walkeriana Felt					×		Ceylon
Genus **COCCODIPLOSIS** de Meijere							
ananasae n. sp.					×		
Genus **DICRODIPLOSIS** Kieffer							
guatemalensis Felt							
Genus **GIARDOMYIA** Felt							
furvescens n. sp.	×				×	×	
pallidithorax n. sp.					×	×	
Genus **LESTODIPLOSIS** Kieffer							
fimicola n. sp.					×		
obtusilobata n. sp.					×		
Genus **LOBODIPLOSIS** Felt							
pseudococci Felt	*	×	*	*	×	*	Mexico
Genus **MICRODIPLOSIS** Tavares							
beardsleyi n. sp.					×		
Genus **NANODIPLOSIS** Kieffer							
pucciniacola n. sp.					×		
Genus **PARALLELODIPLOSIS** Rübsaamen							
bimaculata n. sp.					×		
cattleyae (Molliard)							
Genus **PHAENOBREMIA** Kieffer							
meridionalis (Felt)	×	*	*	*	×	×	Europe, N. America
Genus **TRISOPSIS** Kieffer							
oleae Kieffer					×		S. Africa
Suborder BRACHYCERA							
Family STRATIOMYIDAE							
Subfamily BERIDINAE							
Genus **NEOEXAIRETA** Osten Sacken							
spininger (Wiedemann)	×	×	×	×	×	×	Australasia
Subfamily CLITELLARIINAE							
Genus **BRACHYCARA** Thomson							
latifrons James **n. sp.**					×		Laysan Is.
Subfamily HERMETIINAE							
Genus **HERMETIA** Latreille							
illucens (Linnaeus)	×	×	×	×	×	×	Nearc. & Neotrop. reg., SW Pac., Malta & Italy

	Hawaii	Maui	Molokai	Lanai	Oahu	Kauai	Other Localities
Subfamily PACHYGASTRINAE							
Genus **EVAZA** Walker							
javanensis de Meijere	×	×	*	*	×	×	Indonesia, Malaya
Subfamily SARGINAE							
Genus **CEPHALOCHRYSA** Kertesz							
hovas (Bigot)	×	×	×	×	×	×	S. Asiatic & African regions
Family BOBMYLIIDAE							
Subfamily ANTHRACINAE							
Genus **ANTHRAX** Scopoli							
distigma Wiedemann					×		SE Asia, SW Pacific
Family SCENOPINIDAE							
Genus **LUCIDOMPHRALE** Kröber							
lucida (Becker)			×	×	×		Kaula Is., E. Africa
Genus **SCENOPINUS** Latreille							
adventicia n. sp.	*	*	*	*	×	*	
papuana (Kröber)	×	×			×		Formosa, New Guinea, Mariana Is.
Family EMPIDIDAE							
Subfamily TACHYDROMIINAE							
Genus **CHERSODROMIA** Walker							
dissita Collin **n. sp.**	×		×			×	
hawaiiensis Melander					×		
Genus **CROSSOPALPUS** Bigot							
insularis (Melander)					×		

SUMMARY OF THE NEW NOMENCLATORIAL CHANGES MADE IN THIS VOLUME

TIPULIDAE

Limonia (Dicranomyia) casei Alexander is a new synonym of *L. (Dicranomyia) hawaiienses* (Grimshaw).

Dicranomyia latifrons Grimshaw is a new synonym of *L. (Dicranomyia) hawaiiensis* (Grimshaw).

Dicranomyia foliocuniculator Swezey is a new synonym of *Limonia (Dicranomyia) kauaiensis* (Grimshaw).

Limonia (Dicranomyia) wainaensis Alexander is a new synonym of *L. (Dicranomyia) swezeyi* (Alexander).

Limonia (Dicranomyia) bryani (Alexander) is reduced to a subspecies of *variabilis* (Grimshaw).

CHIRONOMIDAE

Orthocladius (Smittia) maculiventris (Edwards) is a new combination for *Spaniotoma (Smittia) maculiventris* Edwards.

CERATOPOGONIDAE

Forcipomyia (Trichohelea) brevis (Johannsen), new combination for *Apelma brevis* Johannsen.

SCIARIDAE

Leptosciara Frey is treated as a subgenus of *Sciara* Meigen.

Sciara (Lycoriella) johannseni Shaw and *S. (Lycoriella) laffooni* Shaw are new synonyms of *S. (Lycoriella) garretti* Shaw.

Sciara (Lycoriella) stonei Shaw is a new synonym of *S. (Lycoriella) molokaiensis* Grimshaw.

Hyperlasion magnisensoria (Hardy) is a new combination for *Scythropochroa magnisensoria* Hardy.

STRATIOMYIDAE

Euryneurasoma Johnson and *Neurota* Curran are new synonyms of *Brachycara* Thomson.

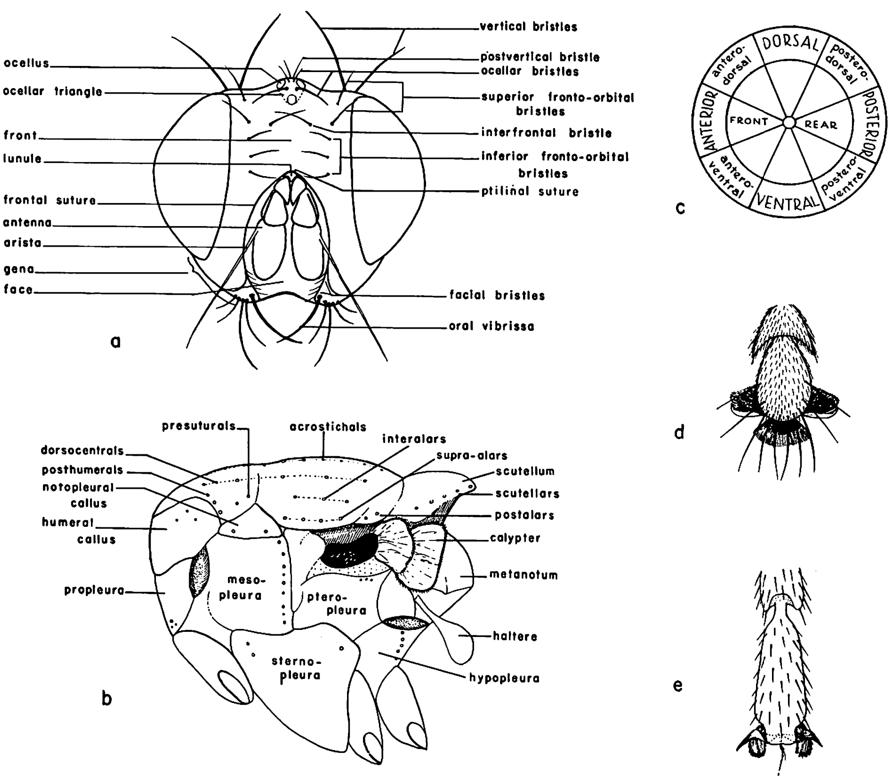

Figure 1—Diagram of some features in an adult fly: **a,** head, front view; **b,** thorax, lateral view; **c,** Grimshaw's system; **d,** last tarsal segment showing empodium well-developed, pulvilliform; **e,** last tarsal segment showing empodium hair-like.

EMPIDIDAE

Crossopalpus insularis (Melander) is a new combination for *Drapetis* (*Crossopalpus*) *insularis* Melander.

Order **DIPTERA** Linnaeus

(from the Greek, *dis*, twice, plus *pteron* wings)

The True Flies

Diptera Linnaeus, 1758, Systema Naturae, ed. 10:584.

INTRODUCTION

The first comprehensive collection of Hawaiian Diptera was made by the late R. C. L. Perkins between 1892 and 1897 and the Diptera portions of the *Fauna Hawaiiensis* were based largely upon the materials which he had collected. Previous to Grimshaw's introduction to the Diptera in the *Fauna Hawaiiensis* (1901), only 22 species had been recorded from the Hawaiian Islands and only about half of these were endemic species. The first descriptions of Diptera from Hawaii were by Thomson (1868), based upon specimens collected when the Swedish frigate "Eugenie" visited the Islands in August, 1852. Thomson described six species from the meager collection of flies taken by the expedition at Honolulu; two of these were endemic species.

Apparently the earliest reference to flies in the Hawaiian Islands was in the account by Ellis (1783) in which the use of "fly flaps" was discussed.

The *Fauna Hawaiiensis* recorded 192 species of flies from the Hawaiian Islands; 135 were listed as endemic and 57 as introduced species. The former represented 27 genera and the latter 46 genera. These were arranged in 26 families.

From then on, the order was entirely neglected (except for scattered reports of economically important species and a few brief taxonomic studies) until Bryan (1934) published his excellent *Review of the Hawaiian Diptera*. Aside from the *Fauna Hawaiiensis*, this is the most important contribution which has been made to the literature on Hawaiian Diptera. Bryan brought the knowledge on the flies up to date and presented a checklist of the known Hawaiian species. He listed 329 species. At least two dozen of these were incorrectly recorded from the Islands or are synonyms, and many of the names were based upon misidentifications. Bryan recorded 42 families in his list. The writer published *Additions and Corrections to Bryan's Check List of the Hawaiian Diptera* (Hardy, 1952) and added 162 species to the list. To the present writing, we now have collected about 800 species of flies from the Hawaiian Islands. These are arranged in 43 families and approximately 210 genera. About 25 families apparently contain endemic species. Some others contain species known only from Hawaii but which are probably not native species. Five new families have been added since Bryan's list; three of his families are not actually represented here and have been removed from the list; and two other families have been lumped together, in keeping with the practices of the specialists in these groups. The bulk of the species fall in the families Dolichopodidae (genera *Campsicnemus* and *Eurynogaster*) and Drosophilidae (genus *Drosophila*), and when these groups have been worked out in detail the list of Hawaiian Diptera should approach 1,000 or more species.

The writer has had an opportunity to study most of the types of Hawaiian Diptera, and has studied all the available collections of Hawaiian flies. The bulk of the material is found in the British Museum (Natural History), the B. P. Bishop Museum, the Hawaiian Sugar Planters' Association, the U.S. National

Museum, and the University of Hawaii. A grant from the National Science Foundation has made it possible to visit the museums which have collections of Hawaiian insects and to collect extensively throughout the Hawaiian Islands. Numerous field trips have been made over Oahu throughout the year for the last seven years and much of the time for several summers was spent collecting on the other islands of the group. The field work has been hampered by the extreme difficulties involved in getting into the remote sections of these islands. Comparatively few trails are extant leading into the mountains and, with few exceptions, the trails that are available are so overgrown with false staghorn fern (uluhe, *Dicranopteris linearis* (Burm.)) or other vegetation that one expends all of his energies cutting his way through with a machete. Many of the regions are completely inaccessible and others can be reached only by hiking long distances over mountainous, densely overgrown, boggy, and wet terrain. Climatic factors often make collecting difficult in many parts of the Islands. The great bulk of the species of endemic flies are found in the wet rain forests or fern jungles at elevations of from 2,000 to 5,000 feet. This is the area of concentrated rainfall ranging from 100 to 400 or more inches of rain per year, where the mountain tops are swampy and the collector is often in mud to his hips. In many areas the collector always gets rained on, the vegetation is continuously soaked and Diptera collecting becomes quite a problem.

I use nylon and bolting silk nets, which dry very quickly, for much of the fly collecting; the water can be shaken out by flipping the net and if the flies are removed after one or two sweeps even delicate species may be collected in good condition in these wet habitats. When the vegetation is dry I use a heavy canvas beating bag with a bolting silk window in the top and selectively collect the individuals with an aspirator as they fly to the window. Collecting has also been done with a wide variety of bait traps, light traps, and by rearing specimens from different media. Different groups require different technics for collecting and one of the shortcomings of this study is that it has not been possible to use enough of the specialized technics over a wide enough area. It is obvious that some of the flies have hardly been sampled up to the present time. Many of the tiny midges, gall flies, fungus gnats, and others have been collected only in light traps, but, with few exceptions, it has not been possible to use this technic satisfactorily in the mountains. A gasoline lantern has been tried, but the nights are almost always too cold and wet for this type of collecting. Another hindrance has been the difficulty in finding satisfactory baits and attractants for trapping some of the native species. More ecological data are needed to improve these technics. Also much more time needs to be spent examining mite, aphid, and scale populations and rearing out the flies which prey upon them.

The taxonomy of some of the families of Hawaiian Diptera is still in a somewhat preliminary state. The present study is the first attempt which has been made to monograph many of the families and, at best, is but a beginning toward the gaining of a thorough knowledge of the Hawaiian flies. We still have comparatively little information on the habits and life histories of our endemic species. It is hoped that clarification of the taxonomy will provide the impetus for detailed

ecologic, biologic, and genetic studies of more of the flies. The Hawaiian Islands and some of the dipterous groups here (especially *Drosophila*, *Campsicnemus*, and *Eurynogaster*) should provide the most ideal conditions in the world for study of speciation and evolutionary trends. For the most part the species are isolated on different islands and in a great many instances are restricted to very localized ecological niches. There are a number of striking examples of unrelated species living in similar habitats on different islands exhibiting remarkable parallelism in development.

Much of the literature on Hawaiian flies has been greatly confused and many of the names used in the past are completely unreliable. Very few of the groups have previously been studied thoroughly, and often complexes of species have been treated under a single name. For example, the name *Sciara molokaiensis* has been used in the past to refer to all of the lowland *Sciara* (over a dozen species); *Liriomyza pusilla* has been used for all of the *Liriomyza* (5 species, none is *pusilla*); our species of *Chyromya* have been called *flava* (Linnaeus), but we apparently have two or more species none of which is *flava*; most of the common species of *Psychoda* have been referred to as *P. alternata Say.*, but we now have 11 known species in this genus.

NOMENCLATURE

The family names of the Diptera have been in a state of confusion for many years and there has been no international agreement concerning the proper names for a large proportion of the families. In all my past work I have attempted to use the names which are in most common current usage (especially in the United States) and which are more nearly correct according to a strict interpretation of the Rules of Zoological Nomenclature and the Opinions and Decisions handed down by the International Commission on Zoological Nomenclature. Regarding Meigen's 1800 names, Opinion 28 (1910) of the Rules states, "the generic names contained in Meigen's Nouvelle Classification, 1800, must take precedence over those in his Versuch, 1803, in every case where the former are found valid under the International Code." Many taxonomists throughout the world have accepted this ruling and many have not, resulting in a complete impasse regarding the generic and family names involved. Since there is obviously no chance of agreement on the Meigen question, the only hope for achieving stability in the names of the Diptera seems to be for the Commission to reverse its stand and take action to suppress the Meigen 1800 names. Curtis W. Sabrosky (1952) has requested the Commission to suppress the Meigen 1800 publication. The Secretary of the Commission has indicated that the matter will be decided in the near future and, since it is highly probable that the 1800 names will be suppressed, I am reverting to the 1803 names and listing the family names based upon Meigen 1800 genera as rejected names.

In following the format used by Zimmerman in preceding volumes of *Insects*

of Hawaii, I have attempted to give the original authors and references for families, subfamilies, and tribes (Zimmerman gave only the year the name was first used, not the reference or synonymy). This has been extremely difficult since there is no ready source for this information on the Diptera and since much of the early entomological literature is not available here in Hawaii. Handlirsch, in Schröder (1925), cited the synonymy known to him under the families, subfamilies and tribes, giving the author and year but no references to the publications. Handlirsch attributed the family names to the first author to use the *idae* ending in each particular case. According to the Copenhagen Decisions (1953:33), the family name is to be based upon the oldest name used in a supergeneric sense regardless of ending. There are some workers who feel very strongly that the family name must be based upon the oldest included genus and there are others who feel that the name should date to the author who first used the *idae* ending (refer to Sabrosky, 1939).

In this work I have attempted to list the major synonyms from the literature I have been able to check (or have checked by others); but I have not given complete synonymies because of the inaccessibility of much of the essential literature. I feel that the attempt I have made to cite the original authors for family names is far from complete and will cause considerable controversy from many sources. It is probable that still earlier available names will be found in some cases. I have purposely avoided replacing well-known family names with some of the names from the early literature which may possibly qualify as being available for family names but which have never been used since the early developmental period of family names (1802–1840). The recognition of the principle of conservation (Copenhagen Decisions 1953: 25, par. 27) would support this stand.

During the course of this study I have had many occasions to refer to Fallén's *Diptera Sveciae*. Only the second volume of this is available here. In this, all of the separate papers have been bound together without the title pages, and it appears as a book authored by Fallén published between 1818 and 1821. In checking back to Horn and Schenkling (1928:343–345), the titles of the various papers (broken down by families) are given and they are cited as dissertations prepared by various of Fallén's students at Lund. I requested Dr. Jean L. Laffoon to check the two volumes of *Diptera Sveciae* in the Iowa State College library. He kindly supplied me with copies of the title pages of each of the papers and also with a copy of the entry to this work in the *Catalogue of the Library of the British Museum* (*Natural History*). Dr. Laffoon decided that "Fallén is not the author of any of the genera or species first described in 'Diptera Sveciae.' Entry #6389 in Horn states clearly that the *Diptera Sveciae* was the compilation of these various papers prepared by his students. The entry in the *Catalogue of the Library of the British Museum* (*Natural History*) Vol. 2 (E–K), p. 555, 1909, is as follows: "Fallén (C. F.) Diptera Sveciae . . . Diptorum antennis parum articulatis instructorum sectionem . . . continens. 2 vol.
4° Lundae, 1814–1827.

Under the above collective title are gathered the following dissertations at the delivery of which Fallén acted as Prasses:—Vol. 1 Sectio prior.

Disposition Dipterorum synoptica, and C. Resp. L. Ståhl. pp. 12, 1817.

Tabanii et Xylophagei Sveciae and C. Resp. G. Wahlberg, pp. 14, 1817."

The catalogue goes on to cite all of the papers, and each is also entered under its actual author with a full citation and a reference to Fallén, Diptera Sveciae.

Dr. Laffoon pointed out that Ståhl, in his *Dispositio Dipterorum Synoptica*, lists all of the parts published in 1817 and gives the students as the authors with no mention of Fallén and notes that most of the papers have dedications and that these are signed by the students.

I have appealed to the dipterists at the U.S. National Museum and the British Museum (Natural History) for their opinions on this matter and all seem to be in complete agreement that the names should be credited to Fallén even though it is not clear just how much of the work he actually did. Dr. Van Emden (submitted in a letter through Paul Freeman) says "that although each part carries the name of a different student, it has been generally accepted ever since publication that the work was really Fallén's and that he farmed parts of it out to his students, possibly as exercises." C. W. Sabrosky, in correspondence, pointed out that Fallén himself apparently regarded these species as his as did Zetterstedt, Fallén's successor at the University of Lund. "Likewise the species were credited to Fallén by Meigen, Wiedemann, and other important dipterists of the time."

Fallén's name has been so firmly entrenched throughout the Diptera literature that there would be no good purpose served by changing to the many completely unfamiliar author names cited on the title pages of the original papers. The Recognition of the Principle of Conservation in the Copenhagen Decisions (1953: 25) would support this stand.

MORPHOLOGY

It should not be necessary to give a detailed account of the morphology of Hawaiian flies. For the most part the important structural details and characteristic features are adequately discussed under each family. One should refer to one of the standard works on Diptera for more complete information. The most outstanding of these works is Lindner, *Die Fliegen der Palaearktischen Region.* Volume 1 (1949) is one of the best references for morphology and other background information on the Diptera. Curran's *The Families and Genera of North American Diptera* (1934); Oldroyd's introductory part to the Diptera in *Handbooks for the Identification of British Insects* (1949); Hendel's Zweiflugler in *Die Tierwelt Deutschlands und der Angrenzenden Meeresteile* (1928); Crampton's external morphology of the Diptera in *Guide to the Insects of Connecticut* (1942); and Usinger's *Aquatic Insects of California* (1956) are very valuable sources of information.

I have attempted to standardize and to simplify the terminology as much as possible. In some cases there are slight, to rather considerable, discrepancies in

interpretation of various morphological structures among families, especially in the male genitalia and as nearly as possible I have preferred to follow the terminologies currently used by the specialists in the different groups. For the chaetotaxy of the head (fig. 1a), thorax (fig. 1b), and legs, refer to descriptions and figures under the various families or to any of the standard works on Diptera. In referring to leg bristles I follow Grimshaw's (1905) system in designating the positions according to the surface on which they occur. The periphery of any given segment, when stretched horizontally from the body, is divided into eight imaginary parts which are called dorsal, posterodorsal, posterior, posteroventral, ventral, anteroventral, anterior, and anterodorsal (fig. 1c). It requires considerable observation to become adept at placing the bristles on their proper surfaces, especially in groups like the *Campsicnemus* Haliday, which often have their legs twisted and distorted so that the surfaces may not be in their true position.

The importance of wing venation characters was recognized by the earliest students of the Diptera, and many systems have been devised for naming the veins. The Comstock-Needham system, with a few modifications, is by far the most practical to use throughout the Diptera. The Loew system (numbering of the longitudinal veins and designating the cells as basal, discal, marginal, submarginal, posterior, etc.) is still widely used (see Curran, 1934) and in many respects is the easiest to apply to some families. It does not work well, however, for groups with reduced venation or those with supernumerary venation; it is often cumbersome or completely confusing to use in referring to careful details of venation or for understanding of homologies. I have previously followed Alexander's (1929) modification of the radial field and had treated the first radial vein as R_{1+2} in the various families of Diptera with which I have worked. In light of more recent studies, it now appears that this stand should be reversed, that R_2 instead of migrating basad and fusing with R_1 has probably migrated distad (as originally contended by Comstock) and has been lost or fused with R_3 in cases where the vein has dropped out. Actually it is most probable that in some groups R_2 has migrated both ways and the picture is still not completely clear regarding the homologies of this as well as other veins. I have followed the venation used by Dr. Hennig (1954), as this seems to be the most up to date study which has come to my attention. The conclusions of H. F. Lower (1951) in his studies of the evolution of the radio-medial area in the wings of Muscoidea Acalyptrata are certainly worthy of careful consideration and in many of the higher Diptera it would seem more logical to consider the hind crossvein (m) as a serial vein consisting of parts of M_2 and M_3 combined with the m crossvein. It is a bit premature, however, to adopt these conclusions; much more work is necessary before it would be practical to make such a radical change in the terminology of the median field.

I have attempted to emphasize the importance of the use of genital structures throughout the Diptera, especially in the males. In many groups the most reliable and, sometimes, the only apparent criteria for separating species are found in the male genitalia. In a comprehensive work of this kind one is handicapped by the lack of agreement on the homologies of the structures throughout the order.

Even at best the homologies of the genitalia between families are difficult to determine, especially between some of the generalized groups, which have the genitalia continuous with the remainder of the abdomen without any dislocation or reduction of parts, and the higher groups where the various parts may be completely dislocated or often reduced or absent. It is quite impossible at the present time to find a set of terms which will satisfactorily apply to the generalized as well as to the specialized families. I have avoided using restrictive or specialized terms wherever possible and have relied mainly upon figures rather than detailed descriptions. I prefer to refer to the structures in relation to their morphological position. In most cases the segments can be counted so that one knows with which portion he is dealing; where reduction of segments has occurred, one can usually account for missing segments from 1–8 by counting the spiracles (after macerating the abdomen in KOH). The cerci are often good landmarks for orienting oneself, representing dorsal appendages of the 11th abdominal segment which is fused with the 10th; they arise near the anal opening and represent the termination of the abdomen. The anal region represents the 10th segment and is dorsal in true position. The 9th segment can be located by the position of the anus. The aedeagus arises from the 9th sternum and various types of appendages, clasping and sensory, are borne on the sternum or the tergum of the 9th segment. Confusion in interpretation often arises when dealing with the torsion or rotation of the genitalia, which occurs in many of the families; the tergal structures are often ventral in position, etc.

ECONOMIC IMPORTANCE

Many species of flies have had a definite effect upon the economy of these Islands. Domestic flies were evidently a native introduction and plagued the Hawaiian people long before the appearance of European ships. The Polynesian people, in their wanderings in the Pacific previous to the advent of the white man, took with them domestic animals such as hogs and dogs as well as coconuts and other plants, and house flies and probably blow flies apparently traveled with them.

William Ellis (1783:156), the assistant surgeon on Captain Cook's voyage of 1778, made the first known reference to Hawaiian insects when he indicated that houseflies were very troublesome to the natives. He wrote, "They have also a kind of fly-flap, made of a bunch of feathers fixed to the end of a thin piece of smooth and polished wood; they are generally made of the tail feathers of the cock but the better sort of people have them of the tropick bird's feathers, or those belonging to a black and yellow bird called Mo-ho. The handle is very frequently made of the bones of the arm or leg of those whom they have killed in battle, curiously inlaid with tortoise-shell; these they deem very valuable and will not part with them under great price. This ornament is common to superiors of both sexes." Captains Portlock and Dixon visited the Islands in May–June,

1786, and made references to the fly swatters or brushes. Portlock (1789:88), when describing supplies purchased from the natives, said: "I purchased two very curious fly-flaps, the upper part composed of very beautiful variegated feathers; the handles were human bone, inlaid with tortoise-shell in the neatest manner which gave them the appearance of fineered [veneered] work." Dixon (1789:272) also described these flaps and said they were used by both sexes to keep the *flies* away. Vancouver (1798:42) visited Hawaii in March, 1792, and mentioned that the natives used these fly brushes for dispersing offending insects. Otto von Kotzebue (1821:306), who visited Hawaii in November, 1816, made several interesting comments concerning pestiferous flies: "The chief employment of the royal ladies consists in smoking tobacco, combing their hair, driving away the flies with a fan and eating." Speaking of the king's daughter (p. 307) he says: "Behind her stood a little negro boy, holding a silk umbrella over her head to protect her from the rays of the sun; two other boys with tufts of red feathers drove away the flies from her." In describing how the sailors were entertained at dinner ashore, Kotzebue (p. 311) said: "Each of them had, like us, a kanaka standing behind him with a tuft of red feathers to drive away the flies." James Montgomery, one of the early missionaries to the Islands, in 1822 (1831:417 and 434) related how abundant and troublesome the flies were; but he indicated that there were no mosquitoes. Apparently the natives had a definite aversion to the flies and Montgomery (p. 472), in referring to the table manners of the natives, writes: "when a common fly was found drowned in their messes, they seemed at once to grow sick and turn away their faces with no equivocal expression of utter loathing. Flies, indeed, may be said to be an abomination with these savages—probably from some superstitious prejudice, for vermin far more disgusting are greedily picked by them from their own bodies—nay, from the very dogs—and devoured." Many of the other early travelers to Hawaii made numerous mention of the annoying flies and of their great abundance. C. S. Stewart (1828:153) described the natives as "eating poi surrounded by swarms of flies."

The feather fly flaps, or devices for brushing away flies, were known as kahilis and these gradually became symbols of rank among the Hawaiians. The kahili bearers accompanied the royalty at most times, especially when they ate or slept, and the fly flaps gradually evolved into the immense symbolic kahilis which were used at funerals and royal occasions and which are still used at special Hawaiian ceremonies.

We have no information which indicates that domestic flies had any affect upon the health of the natives. There are apparently no indications that they suffered from any of the enteric diseases except for an epidemic of diarrhea in 1848–1849 and an outbreak of cholera in 1895 (see Thrum's *Annual* for 1897). Flies could have been instrumental in transmission of these diseases.

The night-biting mosquito (*Culex quinquefasciatus Say*) apparently was imported into the State in water casks on a ship (or ships) from Mexico between 1826 and 1830. There are a number of accounts as to how they first arrived here. Van Dine (1904:7) says, "previous to the year 1826 mosquitoes were unknown

in Hawaii. During that year they were brought to the port of Lahaina, on the Island of Maui, in the ship 'Wellington' from San Blas, Mexico." The account of the first introduction came from Prof. W. D. Alexander from a story related to him by Rev. Wm. Richards who was in charge of the Mission Station at Lahaina in 1826. "Mr. Richards was returning to Lahaina one evening and met a native who informed him that there was a new 'fly' in the place. The native described the insect as being a very peculiar 'fly' that made its presence known by a 'singing in the ear.' Shortly after this, Mr. Richards, being on the outlook for this new fly, heard the 'singing' in his ear and recognized the sound as that of the mosquito, which up to that time had never been heard of in the Islands. Furthermore, up to the year 1826 there was no word in the Hawaiian language for mosquito. The native term is 'Makika,' a corruption of the word mosquito."

Osten Sacken (1861 and 1884) related the following account: "About 1828–30 an old ship from Mazatlan, Mexico, was abandoned on the coast of one of the Sandwich Islands. Larvae of *Culex* were probably imported in the water tanks upon it. The natives soon became aware of the appearance round the spot of a—to them unknown—blood-sucking insect; it so far excited their curiosity that they used to congregate in the evening in order to enjoy the novelty. Since then the species spread in different localities, and in some cases became a nuisance." According to the accounts of Montgomery (1831:434), mosquitoes were not present in the Islands before about 1825. Osten Sacken (*loc. cit.*) said T. R. Peale had related to him that there were "no mosquitoes on the islands about 1823." S. M. Kamakau (one of the earliest Hawaiian historians) was obviously wrong when he implied that mosquitoes were introduced at the time of the arrival of Captain Cook's ships (see Fornander, 1880:199).

Culex quinquefasciatus is still very abundant throughout the Islands wherever suitable breeding habitats occur. It has not been incriminated as a vector of human diseases in Hawaii, but it is a potential vector of two very dangerous diseases (Japanese B-type encephalitis and filariasis) which could easily become established in the Islands. Actually, carriers of the latter disease do occur here among members of our Samoan population, but no case of locally acquired filariasis is known, although experiments conducted by J. Webb in 1946 indicated that the filarial worms would complete their development in the local *Culex* (in personal communication to Bonnet; see Bonnet, 1948:228). Bonnet (1948:229) said, "apparently, there is too small a reservoir of infected humans to permit this abundant mosquito from becoming infected frequently enough to effect transmission." According to a verbal report from Dr. Bonnet, recent studies made in Tahiti have indicated that neither *C. quinquefasciatus* or *Aedes albopictus* are vectors of filariasis in that area.

From a veterinary standpoint this species is especially important as a vector of heart worm of dogs and fowl pox of domestic birds. It also transmits pigeon pox and bird malaria (known only from Japanese hill robins at Kilauea, Hawaii) and may possibly be a vector of *Haemaproteus* of pigeons.

The two day-biting mosquitoes, *Aedes aegypti* (Linnaeus) and *A. albopictus*

(Skuse), apparently did not reach the Islands until a much later date. Perkins (1913:clxxxi) found the former species widespread when he first came to Hawaii in 1892, but said that *A. albopictus* (as "*Stegomyia scutellaris*") did not come to his attention during his early days in the Islands but became very abundant later on. In the latter years of his collecting (probably by 1896–1897) both species were common and very troublesome pests, "not only on the lowlands but also in parts of the lower forests, where in the absence of pools or streams they can breed in great quantities in the small collections of water that forms in hollows of the limbs of trees or where these join the trunk, as well as in the centres of decaying stumps."

Until the concerted control efforts prompted by the last dengue fever epidemic during World War II, *Aedes aegypti* apparently bred in great abundance in the thickly populated sections of Honolulu. And as stated by Knab (1906:270), there was a real danger of yellow fever being introduced into Hawaii by the ships traveling from Mexico and Central America. According to the records, the ship "Hong Kong Maru" arrived here October 30, 1911, from Mexico with yellow fever aboard. According to the account by Usinger (1944:424), "a local watchman who went aboard the ship came down with the disease at Kalihi Camp on October 30 [*sic*]. That there were no secondary cases is doubtless due to the prompt action of health officers. The camp was depopulated, practically denuded, and quarantined, and a general mosquito control program was inaugurated. . . . This campaign is still vivid in the minds of older residents because of the furor over eradication of banana plants as mosquito breeding places. Jack Kalakiela will go down in history as 'Banana Jack' for his part in the affair which finally resulted in payment by the State of Hawaii of over $30,000 in damages to irate citizens." It is questionable whether the reported case was actually yellow fever since the watchman certainly could not have come down with the disease the same day that he boarded the infected ship. Thrum (1912:142) refers to a suspected case on board ship but makes no mention of a possible local case. Of the yellow fever mosquito he says, its "presence here threatens us with grave danger upon the completion of the Panama Canal, as shown in the arrival recently off port of a suspicious case on the 'Hong Kong Maru,' from the Mexican Coast, which was pronounced yellow fever."

Aedes aegypti is now being kept under complete control in Honolulu due to the efforts of the State Board of Health. The species is still present on other Islands but no specimens have been collected on Oahu for over three years. This species is still a definite health menace, however, and any time the control efforts are relaxed it will probably become abundant again. This species obviously is the most effective vector of dengue fever. Although *A. albopictus* is a proven vector of this disease (Simmons, *et. al.* 1930), I find no information concerning the part it might have played in transmission of this disease in Hawaii. This is now the common day-biting mosquito and it is very prevalent throughout the Islands, except in the very dry regions. I question whether it has actually played an important part in dengue transmission in the Islands. If it were an effective

vector here, the disease would not have been brought under control by elimination of only *A. aegypti*.

Dengue apparently first appeared in Hawaii about 1893 and, from all indications, this is the disease which the natives called "Boohoo fever" (refer to Gilbertson, 1945). The first big epidemic was in 1903, when it was reported that 30,000 cases occurred. It broke out again in 1912 and, according to the older residents and doctors, most of the population had dengue. Cases were reported during the years 1913, 1914, and 1915; but the disease did not appear again in epidemic form until 1943 (refer to Usinger, 1944). The disease has not been reported since this time.

Dr. Alonzo Chapin, one of the early missionary doctors from America, in writing on the diseases in Hawaii (in 1838) was greatly impressed by the lack of malaria in the Islands. This was 58 years before mosquitoes were known to be vectors and his remarks are most interesting:

Before going out to the Sandwich Islands, I spent several years in our southern states, much of the time in the low country of South Carolina; and was, during the hot seasons of the year, accustomed to recoil at every standing body of water, on account of the poisonous exhalations which they there emit, endangering the lives of every individual exposed to their influence. On my arrival at the islands, I more than once made the inquiry, "why the numerous kalo (taro) ponds are not productive of sickness." Thousands of acres are entirely converted into ponds of standing water in which the natives cultivate their kalo, while their houses are built on the narrow spaces between. These are never dry, and are often so numerous as to exhaust entire rivers in keeping them filled. I could not at once reconcile my mind to the belief of their innoxious tendency, notwithstanding circumstances are such as to make the fact very obvious. Though the ponds are subject to the perpetual influence of a torrid sun, they cannot become putrid by reason of the continual supply of fresh water, and multitudes of fish live and thrive in them, such is their freshness and purity.

The streams originate from springs and rain on the summits of the mountains, pour down their sides with great impetuosity and after a few meanderings are turned aside from their courses to irrigate the lands and replenish the ponds, or are discharged directly into the sea; and I know of no body of water emitting sufficient miasma to create sickness along its borders. I have occasionally met with stagnant ponds, which emit a foul and offensive odor, and could in no way satisfy myself of the reason for the exemption of the inhabitants along their borders from fevers, but by supposing the effluvia to be diluted and rendered inert by the continual currents of winds.

Small marshes abound but are fed by springs, and the pure mountain streams, and are thus prevented becoming noxious. They speedily dry up during a few weeks' absence of rain; and the rivers also disappear unless kept alive by frequent showers, and the small pools, which remain at such times and which abound after every rainy season, do not become sufficiently putrid to exhale a *fever-generating* miasm.

If any one variety of *soil* has a specific power to produce malaria it does not appear to exist at those islands. The upland soil is there formed of decomposed lava, the lowland plains along the sea are constituted of a mixture of alluvion washed from the mountains, and decomposed coral. Its immunity from noxious exhalations is the same, whether parched with drought, or merely moist, as when the evaporation is most abundant, after the rains.

The habitations of the natives are for the most part considerably scattered, but are in a few instances crowded together in such numbers as to exhibit the dense appearance of our large towns and villages. There is, however, throughout, an entire exemption from those pestiferous exhalations which, so extensively, poison the atmosphere of populous places in hot climates. All animal and vegetable substances thrown away by the people, or cast up by the sea, are quickly devoured by the multitudes of starving dogs and swine, so that no detriment is experienced from their putrefaction.

With so entire an exemption from the existence of miasmata, there is also an entire exemption from those affections induced by it. Malignant bilious fevers do not occur, and as I shall, hereafter, have occasion more particularly to state, derangements of the liver and biliary organs do not prevail, neither is the stomach and intestinal canal, and other organs of the abdominal viscera subject to the numerous and complicated affections so common in every miasmatic region.

Four species of beneficial, predaceous mosquitoes have been purposely introduced to aid in control of *Aedes albopictus* (Skuse). *Toxorhynchites hypoptes* (Dyar) was introduced from Panama in 1953, but the colony died out in the laboratory and the species was not released. *T. inornatus* (Walker) was brought in in 1929 from New Britain (see Pemberton, 1931:360, under "*Megarhinus inornatus*"), but it did not become established. *T. brevipalpis* Theobald, from Africa (see Bonnet and Hu, 1951:237), and *T. splendens* (Wiedemann), from the Philippine Islands (see Weber, 1955:637), were introduced in 1950 and 1954, respectively. These were established in a field insectary at the head of Manoa Valley and mass-rearing technics have been developed for producing them in large numbers. They have been liberated in a number of wet habitats on Oahu, Kauai, Maui, and Hawaii and apparently both species are well established in several localities.

When C. L. Perkins began his collecting for *Fauna Hawaiiensis* in 1892, the biting stable fly (*Stomoxys calcitrans* (Linnaeus)), many of the scavenger and filth breeding species, and several of the hippoboscid parasites of birds were already well established. He first collected the sheep bot fly, *Oestrus ovis* Linnaeus, in 1896; the horn fly, *Siphona irritans* (Linnaeus), was first recorded by Koebele in 1898 (Koebele, 1899).

The horn fly and the stable fly are serious pests of all domestic animals and are often of great annoyance to humans. In the ranching, dairying, and swine producing areas, these flies constitute a constant problem and are one of the chief factors in reducing milk and beef production. The stable fly is a known vector of swine erysipelas in other areas and is also probably a vector of this disease in Hawaii.

Many of the scavenger flies (species of Muscidae, Calliphoridae, Sarcophagidae, Phoridae, Piophilidae, Psychodidae, *et al.*) are potential vectors of numerous enteric diseases which are spread by contamination. The house fly is by far the most significant of the flies which contaminate human food with pathogenic organisms. Compared to most parts of the world, house flies are not a serious problem in Hawaii except where ample breeding media occur. Bridwell (1918:31) said that the predaceous ant, *Pheidole megacephala* (Fabricius), is very beneficial in destroying all stages of flies in their breeding habitats.

Some of these scavengers, including the rat-tailed maggots of Syrphidae, have been incriminated in cases of intestinal myiasis throughout the world, but no cases have come to my attention in the Islands.

Some of the muscoid flies which normally breed in decaying organic matter will occasionally invade living tissue. Some of the blow flies caused extensive damage to sheep in earlier days when these animals were raised more abundantly (see Van Dine, 1908). There are scattered reports in the Hawaiian literature of various types of myiasis of wounds and body openings of different animals, including man, caused by at least two species of blow flies. The latest which has come to my attention involved a 5-month-old baby on Hawaii whose ear was infested with maggots of *Phaenicia sericata* (Meigen) (See Hardy, 1957b).

In other areas *Sarcophaga haemorrhoidalis* (Fallén) and *Phaenicia sericata*

(Meigen) as well as other muscoid flies, *Hermetia illucens* (Linnaeus), and *Eristalis tenax* (Linnaeus) occasionally cause intestinal myiasis of humans (refer to Judd, 1956:117, and Chandler, 1955:721–724).

The sheep ked, *Melophagus ovinus* (Linnaeus), has been reported on the island of Hawaii (see Muir, 1928:4, and Swezey and Williams, 1932:188), but there is no information concerning the importance of this fly in Hawaii. In other areas it causes anemia and intense irritation of the skin and damages the wool of sheep.

At least two of the roundworms which infest the intestinal tract of horses in Hawaii (*Habronema majus* (Creplin) and *H. muscae* Carter) are known to be transmitted by various types of flies (*Musca domestica*, *Stomoxys calcitans*, *et al.*) in other regions. The mode of transmission has not been worked out here, but it is probable that house flies, stable flies, and possibly other muscoid flies associated with horses serve as intermediate hosts for these worms. The eggs of the worms are passed in the feces and are ingested by maggots of flies which breed in horse manure. The worms develop in the fly larva and mature when the adult fly emerges. The horses may become infested with the stomach worms by swallowing infected flies, by swallowing worm larvae which escape from the mouth parts of the fly onto the lips and nose of the host, or by larvae which apparently gain entrance through slight abrasions on the skin or injuries to which the flies are attracted for feeding.

Various intestinal worms of poultry, swine, and other domestic animals are transmitted by flies in other areas, but no investigations have been made along this line in Hawaii. There is also a good likelihood that other parasitic worms of domestic animals in Hawaii may be carried by flies.

Four species of bot flies occur in Hawaii: *Oestrus ovis* Linnaeus, the sheep bot fly; *Hypoderma lineatum* (De Villiers), the common cattle grub; *Gasterophilus intestinalis* (DeGeer), the horse bot fly; and *G. nasalis* (Linnaeus), the throat bot fly. These are rather common in some areas, often cause extensive damage to livestock, and may occasionally attack humans. Two cases have been reported of *O. ovis* larvipositing in the eyes of humans (see Herms, 1925:54, and Hardy, 1956b:13). In one case larvae were removed three weeks after the attack.

Several groups of Hawaiian flies are of importance as agricultural pests. Three introduced species of fruit flies have greatly affected the economy of the Islands. About 1895 the melon fly, *Dacus* (*Strumeta*) *cucurbitae* Coquillett, was accidentally introduced from the Orient. This species is by far the most important pest of vegetable crops in the State. It attacks over three dozen different plants and causes serious losses to crops such as melons, cucumbers, tomatoes, and others. Biological control has not been effective on this species. The Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), reached Hawaii from Australia about 1907. This is a notorious pest of fruits wherever it occurs and was very destructive to soft-pulped fruits in Hawaii prior to the introduction of the Oriental fruit fly, *Dacus* (*Strumeta*) *dorsalis* Hendel, about 1945. The latter species came in, apparently from Saipan, during the latter part of World War II and quickly took over and completely replaced the Mediterranean fruit fly in the lowland areas.

This is one of the most destructive species of Diptera; it has been recorded from about 250 different hosts throughout its range, attacks almost all kinds of fruits and many vegetables, and is one of the most important pests which has invaded the Islands.

Three other species of the fruit fly family have been purposely introduced for control of noxious weeds. Two of these are gall-formers: one, *Eutreta xanthochaeta* Aldrich, forms galls on *Lantana* and another, *Procecidochares utilis* Stone, forms galls on pamakani, *Eupatorium glandulosum* HBK. These have both been influential in control of these weeds. *Xanthaciura connexionis* Benjamin was imported in 1955 to aid in control of the pamakani; it feeds in the flower heads of this plant (Weber, 1956:162).

A group of endemic species of the fruit fly family (Genus *Tephritis*) infests seeds of a variety of native plants of the family Compositae. These are not of noticeable economic importance; however, heavy infestations obviously greatly reduce the number of seeds produced by plants such as the famous silverswords and greenswords (*Argyroxiphium* spp.), several species of *Dubautia*, and other native composites. *Phaeogramma vittipennis* Grimshaw is an endemic species which bores in the stems of native *Bidens* and probably other composites.

Over a dozen species of Agromyzidae, both native and introduced, mine the leaves and stems of a wide variety of plants. Several species are important pests of vegetable crops such as tomatoes, cauliflower, cabbage, squash, eggplants, celery, lettuce, asparagus, etc., and other species seriously damage ornamental plants such as *Nasturtium*, *Datura*, aster, marigold, *Chrysanthemum*, *Lipochaeta*, carnations, *Gnaphalium*, *Zinnia*, and sunflower. At least one species of *Drosophila* (*sadleria* Bryan) is a miner in the stems of native ferns. *Scaptomyza graminum* (Fallén), a miner in leaves of Caryophyllaceae and probably other plants has been recorded in the Hawaiian literature several times but this is an error; this species is not present here. One tipulid (*Limonia kauaiensis* Grimshaw) is a leaf-miner on some of the endemic trees and the ephydrid (*Hydrellia williamsi* Cresson) is a leaf-miner on *Lemna*.

Hylemya cilicrura (Rondani), the seed-corn maggot, is common throughout the Islands and often seriously damages plantings of corn, beans, beets, cabbage, peas, turnips, etc., and, at least on one occasion, has been found damaging silversword plants in Haleakala Crater, Maui.

In the gall-midge family (Cecidomyiidae) we have but one species which is definitely known to be a gall-former; *Diarthronomyia chrysanthemi* Ahlberg often causes extensive damage to plantings of chrysanthemums. *Parallelodiplosis cattleyae* (Molliard), a gall-former on roots of orchids, has been intercepted at Honolulu in quarantine a number of times but is not known to be established. *Contarinia maculipennis* Felt is a miner in blossoms of various flowers, hibiscus, pikake (*Jasminum sambac* (L.)) etc. and *C. sorghicola* Coquillett feeds on seeds of sorghum, Johnson, and Sudan grasses. Some of our species apparently feed on mushrooms and other fungi and the bulk of our cecidomyiids are evidently predators on mealybugs, aphids, mites, and possibly other arthropods.

At least one *Sciara* (*garretti* Shaw) feeds on mushrooms and other fungi and has caused severe damage to commercial plantings of mushrooms on Oahu. This is also probably the same species which Illingworth (1934:535) reported as "*Sciara molokaiensis* Grimshaw, a serious pest of the roots of plants in Hawaii."

Of the beneficial flies, all the members of the family Tachinidae (a half dozen introduced species) are parasites of army worms, cutworms, and a variety of other caterpillars, and one parasitizes the sugarcane borer. Members of the family Pipunculidae (about 50 native species) are parasites of leafhoppers and other Homoptera. Most of the Syrphidae are aphid predators. Members of the family Scenopinidae (three immigrant species) are known to be predators on carpet beetles, clothes moths, and other insects. In the family Drosphilidae, *Gitona perspicax* (Knab) (introduced) is an important mealybug predator; members of the genus *Titanochaeta* (many endemic species) are predators on the eggs of spiders. Two rather recent immigrants, *Pachyophthalmus aliensus* Dodge (Sarcophagidae) and *Anthrax distigma* Wiedemann (Bombyliidae), are predators in the nests of mud-dabber wasps.

There is very little information available concerning the habits and biologies of most of our endemic flies. Some of these may be of economic importance, especially to our native flora. The bulk of our knowledge on the immature stages of Hawaiian flies comes from the careful studies made by Williams (1939, 1943, and 1944).

For information on immature stages of flies refer to Hennig (1948, 1950, 1952), Peterson (1951), and Brauns (1954a and 1954b).

TECHNICS

A great variety of technics, both for collecting and preparation for study, have been used depending upon the situation. As mentioned earlier in the Introduction, most of the collecting has been done with a heavy canvas beating bag containing a bolting silk window at the top, and the flies are collected off the window with an aspirator. This has been supplemented with a fine mesh net of nylon or silk for netting flies on the wing. Much collecting has been done on windows, at lights, and with light traps and bait traps. Also, much material has been reared from a wide variety of media—rotting bark, leaf mold, and other decaying plant materials, as well as from, or in association with, living plants, or with other animals as parasites or predators.

Special collecting problems have been frequently encountered, and specialized technics are needed for some groups; some of these are very time-consuming and are often not very rewarding. It has been very difficult to handle many of the minute, fragile flies satisfactorily, especially in the wet interior country, and some of the groups have obviously been poorly sampled. In order to get perfect specimens of some of the micromidges, it is preferable to kill them and mount them on minuten nadeln as soon as they are collected; this is, of course, impossible very far away from the laboratory. If the specimens are layered carefully soon after

killing, they can usually be brought back in good condition. Some of the specialists on the nematocerous flies recommend that at least part of each sample be preserved in alcohol; this is probably advisable where large series are available. When specimens are preserved in alcohol in the field, the vial should have a wad of cotton on top, should be filled to the top, and all of the air forced out with the cork.

The mounting technics vary greatly depending on the insects involved. The smaller flies are, for the most part, mounted on paper points or minuten nadeln. Water-soluble glue should be used for mounting of midges, mothflies, and other small Nematocera so they can be removed for mounting on microscope slides. Technics for making slide mounts are also variable and it is advisable to follow the technics used by specialists in the different groups. I have found no one method that is satisfactory in all cases. For most flies which must be studied under the compound microscope, I have had good success clearing in KOH, dehydrating in methyl cellosolve, and mounting in balsam; or, dehydrating with alcohol through 95 percent and mounting in euparal; or going through carbol-xylol mixture (3 parts xylol, 1 part carbolic acid) into balsam, or some other permanent medium. In some groups of fragile, delicate flies (especially cecidomyiids), I have not been able to obtain consistently good results; shrinkage and contortion of the appendages has so often resulted that I have had to resort to chloral hydrate–gum arabic mixtures (Hoyer's solution) for the bodies. The wings give no difficulty and are clipped from the body into methyl cellosolve and mounted in balsam or are mounted dry under coverslips with just the edges sealed. After the body has been cleared and mounted in Hoyer's, the slide is dried in an oven for 6–8 weeks and sealed with ringing cement. I am not recommending this technic except where the others fail. It is necessary that one experiment with the various technics being used in the different groups in order to find the one which works best for the material being studied. The results obtained are often directly due to the condition of the specimens rather than to poor technic; often vast differences will be obtained when working with fresh material, dried, and alcoholic specimens. The amount of dissection needed and the orientation of the parts for study differs for various families.

TAXONOMY

The Diptera fauna of the Hawaiian Islands is characterized by the predominance of small and medium-sized flies and is completely lacking in representatives of many of the large, widely distributed families such as Tabanidae, Asilidae, Mydaidae, Bibionidae, Rhagionidae, Therevidae, etc. The family Bombyliidae was not represented until a recent (see Tuthill, 1955:381) accidental introduction of *Anthrax distigma* Wiedemann. Approximately one-third of our species have been introduced (largely accidentally) from other areas of the world, and about two-thirds are apparently endemic. The former group makes up the great bulk of our families and genera. Endemic species are found in comparatively few

genera. There are many more endemic species in the genera *Drosophila*, *Campsicnemus*, and *Eurynogaster* than occur in all the other genera combined.

There is considerable disagreement in the literature regarding the ranking of the families under the section Acalypterae. Many of these families are more difficult to separate (or at least to key) than are most families in other sections, and some of the characters which are used to differentiate these families may seem trivial by comparison. In actual practice, however, characters such as the presence or absence of certain bristles or the convergence or divergence of some of the head bristles are constant enough that they are of importance as key characters. Some of the workers have split up the families in this section rather finely while others have tended to lump the various groups under fewer families. I am following the more conservative treatment in this work. It is obvious that family groupings which will work perfectly for certain geographic regions will often break down when applied from a world-wide standpoint. From my own observation, I am convinced that the Acalypterae families have been split too finely; many cases of intergradation show up when various groups are studied throughout their geographic range. In the future it may prove necessary to combine still more of the families in order that borderline groups may be fitted into the taxonomic scheme.

I have followed the American workers in maintaining the Calliphoridae, Sarcophagidae, Oestridae, and Gasterophilidae in distinct families (refer to Hall, 1948:42–43, and Roback, 1951:347). Many of the workers combine Sarcophagidae under Calliphoridae and Oestridae under Tachinidae (refer to Van Emden, 1954: 1–2); still others put all of these, including Gasterophilidae, as subfamilies under Tachinidae (refer to Lindner, 1949:196–205, Larvaevoridae). As in the acalypterates, many of the family characters of the calypterates break down completely when applied over a wide geographic range, and it is apparent that some of these concepts will have to be modified in the future; but until the sum total of morphological characters, including those of the immature stages, have been more completely evaluated and better agreement reached among the specialists, I prefer to accept these as family groups. I do not consider the separation of the Hawaiian Calliphoridae and Sarcophagidae too satisfactory even though the two groups are readily differentiated just on color differences. The structural details show considerable intergradation, and I have found no structural character which will consistently separate all the species.

Taxonomic Arrangement of the Families and Higher Categories of Hawaiian Diptera

Suborder Nematocera

Tipulidae
Psychodidae
Culicidae
Chironomidae (Tendipedidae)
Ceratopogonidae (Heleidae)
Scatopsidae
Mycetophilidae (Fungivoridae)
Sciaridae (Lycoriidae)
Cecidomyiidae (Itonididae)

Suborder Brachycera

Stratiomyidae
Bombyliidae
Scenopinidae (Omphralidae)
Empididae
Dolichopodidae

Suborder Cyclorrhapha
Series Aschiza

Lonchopteridae (Musidoridae)
Phoridae
Pipunculidae (Dorilaidae)
Syrphidae

Series Schizophora
Section Acalypterae

Gasterophilidae
Otitidae
Piophilidae
Tephritidae
Lonchaeidae
Lauxaniidae (Sapromyzidae)
Sepsidae
Chamaemyiidae (Ochthiphilidae)
Chyromyidae
Anthomyzidae
Tethinidae
Ephydridae
Canaceidae
Sphaeroceridae (Borboridae, Cypselidae)
Asteiidae
Drosophilidae
Agromyzidae
Milichiidae
Chloropidae

Section Calypterae

Oestridae
Tachinidae (Larvaevoridae)
Sarcophagidae
Calliphoridae
Muscidae (including Anthomyiinae)

Section Pupipara

Hippoboscidae

A confusion of concepts of the suborders and other higher taxonomic categories of the Diptera exists in the literature. The most logical and more nearly correct arrangement seems to be that of Oldroyd (1949:31), and his divisions are being followed in this paper. One of the common practices has been to divide the Diptera into two major groups—Orthorrhapha and Cyclorrhapha—based on the mode of exit from the pupal case. In the first group the adult emerges through a T-shaped slit, and in the latter group through a circular seam which detaches from the end of the pupal case. Quoting Oldroyd, "comparison of adult Diptera, both recent and fossil, indicates that the more correct division is first into Nematocera and 'Brachycera' (i.e. all the rest), then 'Brachycera' into Brachycera–Orthorrhapha and Brachycera–Cyclorrhapha. Since the method of emergence is of theoretical interest only, and does not help anyone to name a single adult specimen, which is the usual problem, it is simpler to ignore it, and to group the Diptera directly into three suborders, namely these, for brevity, Nematocera, Brachycera, and Cyclorrhapha."

Dr. Martin Aczél has recently proposed some different concepts for the suborders and higher taxonomic categories of Diptera (1954). He uses the divisions of Latreille (Nematocera [as Nemocera] and Brachycera) for setting off two well-defined suborders, but has rejected as unsatisfactory the groups Orthorrhapha and Cyclorrhapha of Brauer (1880). Under the suborder Brachycera, Aczél has proposed two new divisions—Orthopyga and Campylopyga—based on the folding under of the genital segments of the abdomen in the males of the higher Diptera. Aczél uses the series Homoeodactyla and Heterodactyla (both of Brauer, 1880) under the Orthopyga. The characteristics of the new divisions proposed by Aczél are as follows: Orthopyga—"postabdomen of male never folded beneath the last preabdominal tergite, nor permanently inverted but remaining always as a direct continuation of the preabdomen. Antennae inserted in or just above the prefrontal suture, never below." Campylopyga—"male postabdomen without exception folded beneath last tergite of the preabdomen and circumverted. Antennae inserted below the prefrontal suture and consisting of three segments, scape, pedicel, and postpedicel only." Aczél's conclusions seem very sound and it possibly would be an improvement to use his concepts; but, at least until further studies have been made, I feel it is better to follow Oldroyd's arrangement.

The concepts of the divisions used in this study are as follows:

Nematocera are generally slender, soft-bodied flies with elongate antennae consisting of many similar segments (5 or more in the Hawaiian species) (fig. 26). The palpi are usually 4- or 5-segmented (1-segmented in Scatopsidae and some marine midges, 1- or 2-segmented in some Sciaridae, and 2- or 3-segmented in some Cecidomyiidae). The palpi are normally elongate, slender, and drooping. Wings usually with numerous longitudinal veins, cell first M_2 usually lacking and the cubital cell open. Also the postcranium has no cerebral plate and the male postabdomen is not folded under.

Brachycera are usually fairly large, stout-bodied flies. The antenna is short, 3-segmented (the third segment is annulated in Stratiomyidae) and the segments are not homologous. The palpi are 1- or 2-segmented and are porrect. Wings usually with cell first M_2 present and the venation complete. Also the superior region of the postcranium has a cerebral plate.

The suborder Cyclorrhapha includes the most highly specialized Diptera. Most are short, stout-bodied, with short antennae bearing a dorsal arista and with many bristles on the head and thorax. The families belonging in this group escape from the puparium through a circular opening made by pushing off the anterior end. The adult flies usually possess a ptilinal suture through which the ptilinum is pushed out when the fly emerges from the puparium. Four of the Hawaiian families, however, do not possess this suture, and these fall in the series Aschiza; the remainder fall in the series Schizophora. The series Schizophora is divided into three sections: the Acalypterae, the Calypterae, and the Pupipara.

Key to Families of Hawaiian Diptera*

1. Wings functionally developed 2
   Wings absent or vestigial; flightless species 45

2(1). Antennae composed of six or more segments (figs. 33 and 36). Suborder **Nematocera** 3
   Antennae with not more than three distinct segments (fig. 115c), the third sometimes annulated (fig. 108b). Suborder **Brachycera** 12

3(2). Mesonotum with a V-shaped transverse suture pointed posteriorly (fig. 6e). Two anal veins reaching wing margin. Crane flies . . . . **Tipulidae.**
   Mesonotum without a V-shaped suture. Not more than one anal vein reaching margin 4

4(3). Broad winged, densely haired, moth-like flies, with many longitudinal veins and no crossveins in the wings (fig. 14c). Moth flies . . . . **Psychodidae.**
   Not as above 5

5(4). Body, head, and wings covered with scales. Mouthparts long, slender, fitted for sucking. Mosquitoes . . . . **Culicidae.**
   Not as above 6

6(5). Ocelli present 7
   Ocelli absent 10

7(6). Tibiae with apical spurs. Coxae elongated 8
   Tibiae lacking apical spurs. Coxae short 9

8(7). Wing venation as in fig. 62; r–m crossvein lacking, vein M_{1+2} fused with Rs at base. Eyes separate on the front. Fungus gnats . . **Mycetophilidae (Fungivoridae).**
   Wing venation as in fig. 69b; r–m present as a longitudinal continuation of Rs. Eyes connected by a narrow bridge above antenna (fig. 70a). Dark-wing fungus gnats . . . . **Sciaridae (Lycoriidae).**

9(7). Antennae short, thick, somewhat clavate in shape (fig. 59b). Palpi 1-segmented. Abdomen broad, expanded posteriorly, with only 6–7 segments visible before genitalia. The minute black scavengers . . **Scatopsidae.**
   Antennae usually rather elongate, if short (only in *Anarete*) it is not clavate and the pedicel is greatly enlarged in the male (fig. 81a). Abdomen with 8 visible segments before genitalia. Palpi usually with

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*Compiled mainly from the following sources: Oldroyd (1949:37–43), Brues and Melander (1932:264–352), Lindner (1949:90–104), and Curran (1934:21–27).

4 segments, with 2 only in *Mycophila* and with 3 only in *Monardia*. Gall midges, subfamily **Lestremiinae** . . . . **Cecidomyiidae (Itonididae).**

10(6). Wing venation greatly reduced, not over 4 veins reaching wing margin (fig. 97e). First tarsal segment very short. Antennae long, slender, greatly modified and with circumfila on the flagellar segments of the male (fig. 101f). First two antennal segments about equal in length. Gall midges, subfamily Cecidomyiinae. . . . . **Cecidomyiidae (Itonididae).**

Wing venation not so reduced. First tarsal segment longer than second. Antennae not as above, 1st segment rudimentary (fig. 31c) 11

11(10). Metanotum rather elongated, nearly two times longer than scutellum and usually with a median longitudinal furrow or keel. Vein M_{1+2} simple. Wings not held superimposed over back when at rest. Mouthparts not fitted for piercing. Non-biting midges. . . . . **Chironomidae (Tendipedidae).**

Metanotum rounded, without a median furrow or keel. M_{1+2} forked. Wings held superimposed over back when at rest. Mouthparts sclerotized, fitted for piercing. Biting midges. . **Ceratopogonidae (Heleidae).**

12(2). Empodium well developed, as large as the pulvilli (fig. 1d). Third antennal segment annulated. Wings as in figures 108c, 110b, with 3–4 veins arising from cell 1st M_2. Soldier flies . . . . **Stratiomyidae.**

Empodium hair-like or absent, except in a few species of Dolichopodidae; antennae and wings not as above . . 13

13(12). Front without ptilinal suture 14

Ptilinal suture present (fig. 1a) 21

14(13). Sc and R very strong and reaching costa at or before middle of wing, posterior veins pale (fig. 120a). Only one visible segment in antenna. Hump-backed flies . . . . **Phoridae.**

Wings not as above. Antennae 3-segmented 15

15(14). Wings pointed at apex and with no crossveins in middle (fig. 120c). Pointed-wing flies . . . . **Lonchopteridae.**

Wings not as above 16

16(15). Cubital cell very poorly developed or lacking, never long and pointed. Crossvein r–m at or before basal 3rd of wing 17

Cubital cell well developed and pointed. Crossvein r–m near middle of wing 18

17(16). Proboscis horny, sharp-pointed and conspicuous. Crossvein r–m situated near basal 3rd of wing, cubital cell absent, venation as in figures 118b and 119d. Dance flies . . . . **Empididae.**

Mouthparts not produced into a sharp-pointed beak. Crossvein r–m near basal 5th of wing, cubital cell present but small, venation as in figure 120b. Long-headed flies or long-legged flies . . . . **Dolichopodidae.**

18(16). Veins R_4 and R_5 not united, reaching the wing margin separately 19

R_4 and R_5 fused 20

19(18). Moderately large, furry flies, with four posterior cells in wing, cubital cell open and venation as in figure 113a. Third antennal segment short and with an apical style which is setulose at the tip (fig. 113b). Bee flies . . . . **Bombyliidae.**

Moderately small, bare flies, with three posterior veins, cell Cu closed and petiolate and venation as in figure 114. Third antennal segment two times longer than remainder of antenna and lacking a conspicuous style (fig. 115c). Window flies . . . . **Scenopinidae (Omphralidae).**

20(18). Wings with a spurious vein extending over r–m crossvein; cell R_5 (apical cell) closed. Head hemispherical, face gibbose. Hover flies or flower flies . . . . . . **Syrphidae.**

Wings lacking a spurious vein, cell R_5 open at apex of wing; venation as in figure 120j. Head nearly spherical, made up almost entirely of compound eyes. Face not gibbose (fig. 120j). Big-headed flies . . . . **Pipunculidae (Dorilaidae).**

21(13). Coxae close together, the legs attached ventrally. Body not flattened; not leathery flies 22

Coxae widely spaced so the legs are attached near sides of thorax. Body flattened dorsoventrally and leathery. Parasites of birds. Bird parasite flies . . . . **Hippoboscidae.**

22(21). Second antennal segment without a longitudinal cleft or seam extending the entire length of the segment. Squamae usually vestigial. Thorax without a complete transverse suture in front of wings. Mostly small flies, with eyes well separated in both sexes. Section **Acalypterae** 23

Second antennal segment with a distinct longitudinal cleft or seam along upper outer edge, which extends almost to base of segment (fig. 120e). Squamae usually large and conspicuous. Transverse suture complete, or nearly so. Mostly moderate-sized flies; the eyes of the male often holoptic. Section **Calypterae** 41

23(22). Mouthparts vestigial, sunken in the very tiny oral opening. Horse bot flies . . . . **Gasterophilidae.**
Oral opening large, mouthparts well developed 24

24(23). Costa complete, no indication of a break before end of R_1 25
Costa at least partially interrupted before end of R_1, usually near apex of Sc 29

25(24). Metathoracic spiracle (just below halter) with one long, bristle-like hair in addition to short pubescence (fig. 120g). Moderately small dung-frequenting flies with a large brown to black spot near upper apex of wing. Spiny-legged flies or small dung flies . . . **Sepsidae.**
Metathoracic spiracle without long hairs or bristles (fig. 120h) 26

26(25). Tibiae with preapical dorsal bristles . . . . . . **Lauxaniidae.**
Tibiae without preapical dorsal bristles 27

27(26). Veins R_1 and R_{2+3} ending very close together. Sc not complete, only the basal portion developed (fig. 120d) . . . . **Asteiidae.**
Wings not as above. Sc complete or nearly so 28

28(27). Postvertical bristles absent. Sc ends near tip of R_1. Vein Cu faint, poorly developed; cell Cu very short. Rather small gray flies with hyaline wings . . . . **Chamaemyiidae.**
Postvertical bristles well developed and divergent. Sc well separated from R_1. Vein Cu and cell Cu well developed. Wings usually pictured. Pictured-wing flies . . . . **Otitidae.**

29(24). Hind metatarsi shortened and incrassate (fig. 120f). Branches of M beyond cell 1st M_2 usually evanescing before wing margin . . . . **Sphaeroceridae (Borboridae).**
Not as above 30

30(29). Cubital cell entirely lacking 31
Cubital cell present 32

31(30). Subcostal vein rudimentary; costa interrupted only at spot where Sc should end. Postvertical bristles convergent, usually cruciate. Ocellar triangle large and

shining, occupying most of front. Frit fly family..... .... **Chloropidae.**

Basal portion of Sc present; costa distinctly broken in two places. Postvertical bristles divergent or absent. Ocellar triangle normal in size. Shore flies or brine flies.................................. **Ephydridae.**

32(30). Costa twice broken, once near humeral crossvein and once near apex of subcosta........................33

Costa broken only at end of subcosta................35

33(32). Subcosta free from, and well separated from, R_1 and abruptly curved upward at nearly a right angle. Cubital cell acutely pointed (fig. 120k). Fruit flies. .... **Tephritidae.**

Subcosta incomplete, vestigial or fused with R_1 near tip. Cubital cell not pointed......................34

34(33). One or more of the lower fronto-orbital bristles are directed inwards. Arista bare or very short pubescent.................................. **Milichiidae.**

No inwardly directed lower fronto-orbital bristles. The lowest fronto-orbital may be directed forward, backward, or outward. Arista bearing long rays (fig. 120i). Small fruit flies, vinegar flies........... **Drosophilidae.**

35(32). Antennae widely separated by the swollen upper portion of the face. Clypeus large and projecting above mouth. Beach flies..................... **Canaceidae.**

Antennae close together. Clypeus small, not projecting..36

36(35). At least 1 strong bristle present just above oral margin..37

Oral vibrissae absent, the genae are haired but these are not on the area surrounding the oral margin. Head hemispherical; eyes vertical; front of male narrow, ¼–⅕ the width of head; female with long ovipositor; Sc well separated from R_1.... **Lonchaeidae.**

37(36). Only 1 strong oral bristle present on each side near upper edge of oral margin. Eyes round, genae very broad, ⅔ eye height. Frontal bristles lacking. Cheese skipper family.................. **Piophilidae.**

A row of bristles present above oral margin. Genae much narrower and frontal bristles well developed....38

38(37). Postvertical bristles well developed and diverging. Leaf-mining flies.................... **Agromyzidae.**

Postvertical bristles small and converging, or absent....39

39(38). Presutural dorsocentral bristles present (4 pairs of dorsocentrals)........................ **Tethinidae.**

Not over 2 pairs of postsutural dorsocentrals (no presuturals) 40

40(39). Third antennal segment bent at nearly a right angle to the second. Arista bearing long rays. Base of vein M_{3+4} evanescent, not clearly marking off cells 1st M_2 and M. Crossvein r–m situated at middle of 1st M_2. Subcosta not complete. Chiefly black species . . . . **Anthomyzidae.**

Third antennal segment not bent downward. Arista bare. Base of M_{3+4} well developed. Crossvein r–m situated near apical 3rd of 1st M_2. Subcosta complete, separate from R_1 but lying close to this vein. Entirely yellow species . . . . **Chyromyidae.**

41(22). Mouthparts well developed. Often bristly species, at least sternopleural bristles well developed, and a row of bristles on hypopleura, except in Muscidae 42

Oral opening very small, mouthparts vestigial. Body pilose but never bristled. Hypopleura with long hairs. Bot flies . . . . **Oestridae.**

42(41). Hypopleura with a row of strong bristles 43

Hypopleural bristles absent, though some small hairs may be present. House flies and allies . . . . **Muscidae** (including **Anthomyiidae**).

43(42). Postnotum strongly convex, projecting conspicuously beneath scutellum . . . . **Tachinidae.**

Postnotum not convex or prominent 44

44(43). Metallic blue-green or purple flies, or if dull black (*Pollenia*) with tawny yellow crinkly hair over most of body, or with the face produced and the abdomen rufous (*Rhinia*). Lower portion of propleura (depressed area) densely pilose, except in *Rhinia* and *Pollenia*. The outermost posthumeral bristle lies outward of a longitudinal imaginary line through the presutural bristle. Blow flies . . . . **Calliphoridae.**

Predominantly gray species with longitudinal black stripes down the mesonotum. Lower portion of propleura usually bare, sometimes with sparse setae. The outermost posthumeral lies inward of or on a line drawn through the presutural. Flesh flies . . . . **Sarcophagidae.**

45(1). Wings and halteres absent 46

Wings and halteres present, the former reduced to narrow lanceolate appendages. (*mirabilis*-complex of *Campsicnemus* Haliday) . . . . **Dolichopodidae.**

46(45). Leathery bodied, tick-like parasites on sheep; coxae widely separated on the sternum and the palpi elongated, forming a sheath for the proboscis. Sheep ked. .... **Hippoboscidae.**

Not as above; very tiny flies 47

47(46). Antennae 5–7-segmented. Marine midges (*Clunio* Haliday) .... **Chironomidae.**

Antennae with only one visible segment and bearing an arista. Rather booklice-like species. (*Puliciphora* Dahl and *Chonocephalus* Wandolleck) .... **Phoridae.**

Suborder **NEMATOCERA** Latreille

Nemocera Latreille, 1817, in Déterville's Nouv. Dict. d'Hist. Nat. (2nd ed.), 10:288.

Nematocera Brauer, 1880, Zweifl. des Kaiserlichen Mus. zu Wien, p. 111.

These are the most primitive of the Diptera. The suborder evidently first appeared in the Permian epoch and led to the Brachycera and higher groups by the Tertiary period.

The Nematocera are differentiated by their many-segmented antennae, usually seven or more segments in the Hawaiian species, but with only five segments in female *Clunio*, and six segments in the females of *Calopsectra;* as well as by other characteristics pointed out in the discussion of the suborder under Taxonomy.

The name Nemocera, as originally proposed by Latreille, was grammatically incorrect and was emended to Nematocera. The latter seems to be the most commonly used spelling in the literature so is being used in this study. The suborder was commonly treated as a "family" under the name Tipulariae by early workers. This arrangement was used as late as 1848 and 1862 by Walker (1848:1) and Osten Sacken (1862:1).

Family TIPULIDAE Latreille
Crane Flies

Tipulariae Latreille, 1802, Hist. Nat. Gen. et Part. des Crust. des Ins. 3:419.

Tipularides Leach, 1815, in Brewster's Edinburgh Encyclopaedia 9:161.

Tipulidae Samouelle, 1819, The Entomologist's Useful Compendium, p. 290.

Tipulaedes Billberg, 1820, Enum. Ins. Mus. Billberg, Stockholm, Gadel 4:121.

Limnobiina Rondani, 1856, Dipt. Ital., Parma 1:179.

Limoniidae Speiser, 1909, in Sjostedt's Wissenschaft. Ergebnisse der Schwedischen Zool. Exped. Kilimandjaro, 10, Dipt. 4:45.

Limnobiidae Malloch, 1917, Bull. Ill. State Lab. Nat. Hist. 12, art. 3-183.

For a more complete list of the synonyms under the family see Handlirsch, in Schröder (1925:964).

The name of the family comes from the Latin "tipula," that which runs swiftly over the water; the water spider. Used to express something very light.

These are slender-bodied, long-legged flies distinguished from related families of Nematocera by the presence of a V-shaped suture on the mesonotum separating the praescutum and the scutum (fig. 6e), by having no ocelli, and by the presence of two anal veins in the wing (fig. 4e). The legs are characteristically long and slender and very brittle, and it is difficult to keep them on the specimens.

The Hawaiian crane flies are all moderately small species, ranging in size from 3.0 to 9.0 mm. Our species all belong in the subfamily Limoniinae or the so-called "short-palped crane flies." No representatives of the Tipulinae or Cylindrotominae have been recorded in the State.

The Hawaiian species breed in a wide variety of habitats and range from those that mine inside leaves to those that live in various semiaquatic to aquatic situations. They are commonly collected along streams, in dark places and in vegetation, especially in heavy shade in dense foliage. The lowland (introduced) species are often abundant at lights. A number of species of *Limonia* (*Dicranomyia*) have the peculiar habit of swinging the body rapidly up and down when at rest. According to Barnes (1924), this bobbing is associated with egg laying, the flexing of the legs and swinging of the body forcing the ovipositor into the soil. At least some of the Hawaiian species—such as *L. grimshawi* (Alexander), *stygipennis* (Alexander), *variabilis* (Grimshaw), and *hawaiiensis* (Grimshaw)—are commonly seen bobbing up and down when in resting habitats. One often encounters the males of some species congregated in mating swarms dancing up and down in deep shade in the mountains.

The tipulids are classified largely by the details of their wing venation, male genitalia, and mouthparts. The male genitalia present very striking characteristics for distinguishing between genera as well as species. The terminology used is patterned after Alexander. That of the wing venation is quite self explanatory, except for a few details, since the wings are mostly generalized types conforming rather closely to the hypothetical wing scheme of the Comstock–Needham system. It is obvious however that Sc_2, when it is present, has fused with vein R_1 over most of its length. This leads to considerable controversy and confusion regarding the interpretation of the terminal portion of the combined Sc_2 and R_1. Hennig (1954:260) and Edwards (1938b:8) have not accounted for Sc_2 beyond its furcation from Sc_1 and in the *Limonia* (*Dicranomyia*) they have interpreted the short vertical vein in alignment with R_2 to be R_1. In many of the species of *Dicranomyia* a short appendix of a vein is present at the tip of Sc_2+R_1 (fig. 9a) and it seems obvious that the vertical section is the free tip of vein Sc_2 or, in some cases, may be Sc_2+R_1. I am also assuming that when R_2 is present it arises as a vertical branching from the upper branch of the radial sector (R_{2+3}) (fig. 2a). The male genitalia are usually complexly developed; the aedeagus often has well-developed accessory structures. The dististyli are bilobed and often the ventral dististylus is greatly inflated and with a rostral prolongation bearing strong spines; the dorsal dististylus is elongate, slender and rather hooklike (fig. 6f) and the basistyli are often strongly lobate.

For more complete morphological details refer to Alexander (1919, 1942, and others), Edwards (1938b), and Coe (1950).

The larvae of Tipulidae are generally recognized by the head capsule which is more or less deeply retracted into the prothorax. They are slender, cylindrical, and dull colored. Most of our knowledge of the immature stages of Hawaiian species comes from the work of Williams (1943:313–324). He presented information on the habits of six of our species. Swezey (1915) gave an excellent account of the leaf-mining species *Limonia (Dicranomyia) foliocuniculator* (Swezey) = *kauaiensis* Grimshaw. For biological information refer to the above cited references; also Alexander (1921), Peterson (1951:256), Malloch (1917:191–238) and Brauns (1954a:63–69 and 1954b:64–76).

According to Williams (1943:324), the Hawaiian tipulids have numerous enemies in their adult and immature stages. They are fed upon by spiders, dragon flies and damsel flies, crabronid wasps, a *Philonthus* sp.? (Staphylinidae), *Saldula* bugs, *Microvelia vagans* (White), the carnivorous larvae of anthyomyiid and dolichopodid flies, mites, and are subject to diseases (probably fungal). No parasites of tipulids have been reported in Hawaii.

Many workers have treated Limoniinae as a distinct family, but F. W. Edwards and C. P. Alexander (the leading authorities on the group) have considered it a subfamily of Tipulidae. Dr. M. J. D. White (1949:254) has concluded that on the basis of cytological evidence Limoniinae not only represents a distinct family but should even be removed from the superfamily Tipuloidea and placed with the Psychodidae, Simuliidae, Culicidae, and Chironomidae. This arrangement would certainly seem illogical as long as we continue to base the phylogenetic scheme largely on morphology.

Subfamily LIMONIINAE Enderlein

Limnobiina Rondani, 1856, Dipt. Ital., Parma 1:179.
Limnobiaceae Osten Sacken, 1862, Proc. Acad. Nat. Sci. Phil. 1861, p. 287.
Limnobinae Schiner, 1864, Fauna Austriaca, 2:526.
Limnobiinae Lamb, 1909, Dipt. Sub-Antarctic Islands of N. Zealand, 1, Art 7:124.
Limoniinae Enderlein, 1912, Zool. Jahrb. Abt. für Syst. 32:72. Edwards, 1938, Trans. Soc. Brit. Ent. 5(1):18.
Limnobiidae Malloch, 1917, Bull. Ill. State Lab. Nat. Hist. 12, art. 3:183.

Members of this subfamily are predominantly small-sized crane flies, whereas the Tipulinae are usually comparatively large. The palpi are short; the last segment is about equal to the two preceding segments rather than being much longer than the three preceding segments. For further details refer to Edwards (1938:18). Most species of Limoniinae rest with their wings folded one over the other over the abdomen, unlike the majority of the Tipulinae.

KEY TO TRIBES, GENERA, SUBGENERA AND SOME SPECIES OF *Limoniinae*

1. The free portion of Sc_2 is in transverse alignment with vein R_2 (fig. 9a). Tribe **Limoniini. Limonia** Meigen . . 2
   Sc_2 not present as a free portion in alignment with R_2. If vein R_2 is present, it is well removed from the tip of R_1 (figs. 2a and 5a). Tribe **Eriopterini** 4

2(1). Mouthparts as long as the head and thorax combined (fig. 12d) . **Limonia (Geranomyia) advena** Alexander.
   Mouthparts not elongated 3

3(2). Vein R_3 strongly arched and ending at or slightly below the wing apex. The m crossvein is over two times longer than the basal section of vein M_3 and extends almost parallel to vein M_{1+2}. Cell 1st M_2 is elongate, about four times longer than wide and over three times longer than vein M_4. The m–cu crossvein is placed well beyond the base of cell 1st M_2 (fig. 13a). . . . . **Limonia (Libnotes) perkinsi** (Grimshaw).
   R_3 not so arched, ending well before the wing apex. The m crossvein is nearly vertical in position and is about half as long as the basal section of M_3. Cell 1st M_2 short, not over two times longer than wide and not equal in length to M_4. The m–cu crossvein is situated at or slightly before the base of cell 1st M_2 (fig. 9a) . . . . **Limonia (Dicranomyia)** Stephens.

4(1). Sc and R_1 end close together before the middle of the wing. The anterior branch of Rs diverges strongly from the posterior branch, it arises opposite or slightly before the r–m crossvein, and is oblique or nearly vertical in position (fig. 5a) . . . . **Styringomyia didyma** (Grimshaw).
   Wings not as above 5

5(4). Vein R_2 present as a crossvein near forking of R_{2+3} and R_{4+5} (fig. 2a). Base of Rs near basal third of wing. Middle and hind coxae rather widely separated, the meron very large (fig. 3a). **Erioptera** Meigen 6
   Vein R_2 absent. Base of Rs near middle of wing. Mid and hind coxae close together, the meron small (fig. 3b) . . . . **Gonomyia (Lipophleps)** Bergroth.

6(5). Cu_1 straight, its distal portion not bent upward. Cell 1st M_2 closed . . . . **Erioptera (Trimicra) pilipes** (Fabricius).
   The distal portion of Cu_1 is bent upward toward the wing tip. Cell 1st M_2 open . . . . **Erioptera (Meterioptera) bicornifer** Alexander.

Tribe Eriopterini Osten Sacken

Eriopterina Osten Sacken, 1869, Smiths. Misc. Coll. 8, art. 1, p. 135.
Eriopterini Brunetti, 1912, Fauna Brit. Ind., Dipt. Nematocera, p. 436.
Styringomyiini Alexander, 1920, Cornell Univ. Mem. 38:977.
Eriopterinae Brues and Melander, 1932, Bul. Mus. Comp. Zool. 73:268.
Polymidinae Brues and Melander, 1954, Bul. Mus. Comp. Zool. 108:309. (This should have been spelled Polymedinae, based upon *Polymeda* Meigen 1800.)

Members of the tribe are easily differentiated from other Hawaiian Tipulidae by the four branches in the radius. Three genera and two subgenera occur in Hawaii.

Genus **ERIOPTERA** Meigen

Polymeda Meigen, 1800, Nouv. Class. Mouch., p. 14 (a rejected name).
Erioptera Meigen, 1803, Mag. fur Insektenk. 2:262.

Stone, in correspondence, has indicated that the name *Erioptera* belongs by first type selection to what Alexander calls *Molophilus*, and that if *Polymeda* is not used for *Erioptera* of Alexander, nec Meigen, then some other name must be resurrected for the genus. (Refer to Stone, 1941:413.) I do not feel that I am qualified to take action on this matter.

The Hawaiian species in this genus can be distinguished from other Eriopterini by the wing venation (vein R_2 is well developed as a crossvein near the forking of R_{2+3} and R_{4+5} (fig. 2a), by the widely spaced coxae of the middle and hind legs, and by the very large meron (fig. 3a).

Type of genus: *Erioptera grisea* Meigen.

Subgenus **METERIOPTERA** Alexander

Erioptera (Meterioptera) Alexander, 1934, Phil. Jour. Sci., 53:462.

In Hawaii this is distinguished from *Erioptera (Trimicra)* by the open cell 1st M_2 in the wing and also by the distal portion of vein Cu_1 which is curved upward toward the wing tip (fig. 2a).

Just a single species occurs in Hawaii.

Type of subgenus: *Erioptera javanensis* de Meijere.

Erioptera (Meterioptera) bicornifer Alexander (figs. 2a–c).
Erioptera (Erioptera) bicornifer Alexander, 1921, Ann. Ent. Soc. Amer. 14:116.
Erioptera (Meterioptera) bicornifer Alexander, 1941, Proc. Haw. Ent. Soc. 11:24.

Oahu, Hawaii, and probably all of the main Islands.

Immigrant. Described from Japan, but widely distributed throughout East Asia.

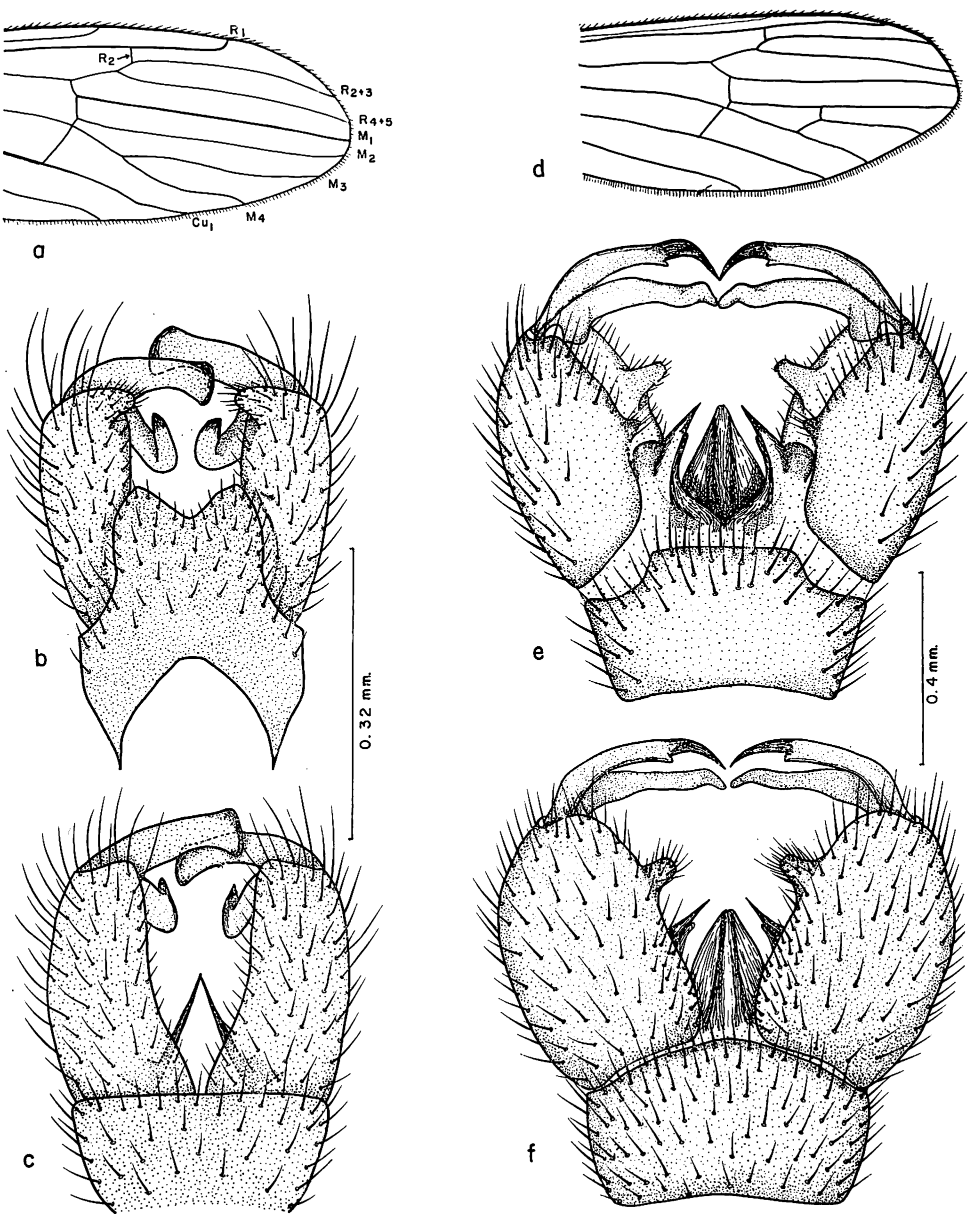

Figure 2—*Erioptera* (*Meterioptera*) *bicornifer* Alexander: **a,** apex of wing; **b,** male genitalia, dorsal view; **c,** male genitalia, ventral view. *Erioptera* (*Trimicra*) *pilipes* Fabricius: **d,** apex of wing; **e,** male genitalia, dorsal view; **f,** male genitalia, ventral view.

Type in Alexander's collection, Amherst, Mass.

A small, pale brownish species without distinct markings on the thorax and with the pleura sparsely gray pruinose. Wings pale gray, veins brownish. The venation as in figure 2a. Vein Cu_1 is bent rather sharply upward at its apex. Male genitalia as in figures 2b and 2c.

Length: body, 3.0 mm.; wings, 4.2 mm.

Williams (1943:323) bred this species from mud in the lowlands near Honolulu. He said "The egg is much like that of *Trimicra pilipes* but is smaller. The pupa has slender forward-curved breathing horns."

Subgenus **TRIMICRA** Osten Sacken

Trimicra Osten Sacken, 1861, Proc. Acad. Nat. Sci. Phila., p. 290.

This is distinguished from other *Erioptera* in Hawaii by the closed cell 1st M_2 and the straight vein Cu_1 (fig. 2d). The single species represented in our fauna is also much larger and more densely haired than is our only known species of *E.* (*Meterioptera*).

Type of subgenus: *Trimicra anomala* Osten Sacken.

Erioptera (Trimicra) pilipes (Fabricius) (figs. 2d–f).

Tipula pilipes Fabricius, 1787, Mantissa Insectorum, p. 324.

Trimicra lateralis Grimshaw, 1901, Fauna Haw. 3 (1):9. Synonymy by Edwards, 1921, Trans. Ent. Soc. Lond., p. 219.

Erioptera (*Trimicra*) *pilipes* (Fabricius), Edwards, 1938, Trans. Soc. Brit. Ent. 5(1):129.

Oahu, Kauai, Hawaii, and probably all of the main Islands.

Immigrant. Very widespread throughout Europe, North America, Africa, the Middle East, and over much of the world.

The type may possibly be in the Zoologische Museum at Kiel.

A small to medium-sized, predominantly brown and densely pilose species; extremely variable in size and somewhat so in coloration. The head is light brown with a dark median stripe. The antennae are dark brown except for the basal two joints which are yellow. The mesonotum varies from dull brown with a black median stripe to brownish yellow with three indistinct brown longitudinal stripes. Wings slightly infuscated, especially along the veins. Venation as in figure 2d. Vein R_2 present as a crossvein near forking of R_{2+3} and R_{4+5}. Legs densely clothed with long fine erect hairs; femora with a brown ring before apices. Abdomen dark brown with lateral margins pale yellow. Genitalia conspicuous, reddish yellow; the structures developed as in figures 2e–f.

Length: body, 4.0–7.0 mm.; wings, 6.0–10.0 mm.

Williams (1943:322) found this species breeding in the mud in lowland marshes on Oahu and on the margin of a taro pond on Hawaii. He reared a specimen from

egg to adult in 21 days. He said, "the spiracular disc of the larva is strongly hairy lobed; the lobes may be brought together to form an air cup. The pupa including the rather forward-pointing breathing horns may attain a length of about 10 mm. It is armed with a sort of thorny collar on the shoulders."

Genus **GONOMYIA** Meigen

Gonomyia Meigen, 1818, Syst. Beschr. Zweifl. Ins. 1:147.

The members of this genus in Hawaii can be readily distinguished from other Eriopterini by the lack of vein R_2 (fig. 4e), by the radial sector arising near the middle of the wing rather than near basal third, and by the middle and hind coxae being close together, with a small, poorly developed meron (fig. 3b).

One subgenus and two species occur in Hawaii.

Type of genus: *Limnobia tenella* Meigen.

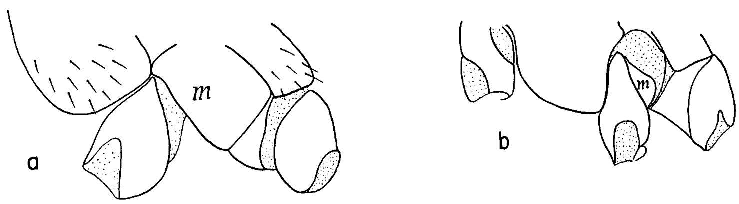

Figure 3—Lower part of pleura showing size of meron (m): **a,** *Erioptera;* **b,** *Gonomyia.* (Copied from Edwards, 1938, Trans. Soc. Brit. Ent. 5(1):97.)

Subgenus **LIPOPHLEPS** Bergroth

Lipophleps Bergroth, 1915, Psyche 22:55. Change of name for *Leiponeura* Skuse, 1890, Proc. Linn. Soc. N. S. Wales (2) 4:795. *nec. Liponeura* Loew, 1844, Ent. Ztg., Stettin 5:118.

Differentiated from typical *Gonomyia* by having the Sc ending before base of Rs; vein R_{2+3} not arched upward and cell R_5 narrowed at its apex.

Type of subgenus: *Leiponeura gracilis* Skuse.

Key to Hawaiian Gonomyia (Lipophleps)

1. No secondary lobes present on the basistyli (fig. 4b). The apical lobe of each basistylus is longer than the basal portion, as seen in dorsal view (fig. 4a). (Oahu, Maui) . . . . **hawaiiensis** Alexander.

Each basistylus with a moderately strong secondary lobe arising on the venter at the base of the dististylus and extending almost as long as this structure (fig. 4d). The apical lobe of the basistylus is shorter than the basal portion (fig. 4c). (Molokai)........ ....**molokaiensis** Hardy.

Gonomyia (Lipophleps) hawaiiensis Alexander (figs. 4a–b).

Gonomyia (Leiponeura) hawaiiensis Alexander, 1919, Ann. Ent. Soc. Amer. 12:30.

Gonomyia (Lipophleps) hawaiiensis Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):9.

Endemic. Oahu and Maui and probably on the other main Islands. (Type locality: Koolau Mountains, Oahu, 1,500 feet.)

Type in Alexander's collection.

A small, chiefly brown species distinguished from other Hawaiian crane flies by the generic and specific characters given in the keys above. As in *G. molokaiensis* Hardy, the extreme lateral margins of the mesonotum are yellow and the pleura have a broad white band extending longitudinally through the median portion. The knobs of the halteres are bright yellow. For details of the genitalia see figures 4a and 4b. The female ovipositor has the dorsal valves very long and slender, slightly up-curved, dark brown at base, yellow beyond.

Length of body: 2.8–3.4 mm.

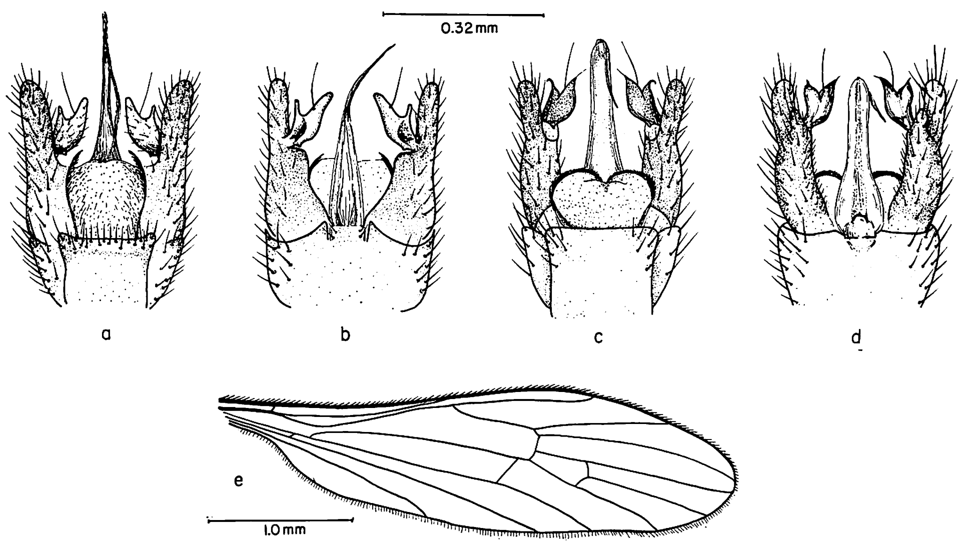

Figure 4—*Gonomyia (Lipophleps) hawaiiensis* Alexander: **a,** male genitalia, dorsal view; **b,** male genitalia, ventral view. *G. (Lipophleps) molokaiensis* Hardy: **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view; **e,** wing.

This species apparently breeds in wet habitats at higher elevations. Williams (1943:322) found larvae of what appeared to be this species "in mud and minute plant growth of a spring high up on Mt. Kaala. The larva in one case measured 8 mm. long. It was dull wood-brown in color and was in great measure covered with fine erect pile giving it a velvety appearance. This pile was more patchy on the thorax, and there were some fine erect hairs before the caudal extremity. The small head was retractile, the thoracic segments rather conspicuously arched, while the abdomen, lacking any creeping welts, was swollen bulb-like before the caudal end that bears the 5-lobed spiracular disc so well marked by blackish strips. Short digit-like gills are present caudally beneath."

Gonomyia (Lipophleps) molokaiensis Hardy (figs. 4c–e).

Gonomyia (Lipophleps) molokaiensis Hardy, 1953, Proc. Haw. Ent. Soc. 15:57.

Endemic. Molokai (type locality: Puu Kolekole, 4,000 ft.). Taken from sweeping vegetation in a marsh on top of the Molokai mountains.

Type in the U. S. National Museum.

Closely related to *G. hawaiiensis Alexander* and can be satisfactorily differentiated only by the male genital characters. The most striking difference is the bilobed development of the basistyli; a moderately strong secondary lobe is present at apex of each dististylus on the venter (fig. 4d).

Length: body, 3.0 mm.; wings, 4.0 mm.

Genus **STYRINGOMYIA** Loew

Styringomyia Loew, 1845, Dipterologische Beitrage 1:6.

This genus is readily distinguished from others in the Hawaiian fauna by its two-branched radial sector, with the anterior branch strongly oblique or nearly vertical in position; by having vein R_1 ending before the middle of the wing and close to the apex of Sc (fig. 5a); and by genital characters (fig. 5b).

Alexander (1920:977) proposed that this genus be placed in a tribe Styringomyiini. Later, in Curran (1934:49), Alexander reduced this to a subtribe of Eriopterini. He said, in correspondence, that "except for some peculiarities of wing venation there seems actually to be no great difference, and in my opinion certainly not enough to indicate a tribe."

Alexander says there are now approximately 100 species in this genus. Only one species is known from Hawaii.

Type of subgenus: *Styringomyia venusta* Loew.

Styringomyia didyma Grimshaw (figs. 5a–b).

Styringomyia didyma Grimshaw, 1901, Fauna Hawaiiensis 3(1):10.
Idiophlebia pallida Grunberg, 1903, Zool. Anz. 26:524.

Synonymy by Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):10.

Oahu, Maui, Hawaii and probably all the main Islands. (Type locality: Honolulu.)

Immigrant. Widely distributed throughout Australasia; Fanning Island, Palmyra, Samoa, Tonga, Fiji, Society Islands, Caroline Islands, New Hebrides, and New Guinea.

Type in the British Museum (Natural History).

Our single species of *Styringomyia* can be recognized by the distinctive generic characters. The veins Sc and R_1 end before the middle of the wing and the anterior branch of Rs diverges strongly from the posterior branch and extends nearly vertical in position (fig. 5a). The comparatively short wings and chironomid-like appearance make this species easy to distinguish.

Our species is predominantly yellow to rufous and the femora are long haired and with two brown spots. The antennae and palpi are yellow, the 1st antennal segment is two times longer than the 2nd. The thorax is reddish brown with a large subtriangular, light yellow spot on each side immediately behind the suture and merging into the light yellow coloring of the pleura. Wings are yellowish hyaline, veins pale, and venation as in figure 5a. The abdomen is long and slender, light yellow, and each tergum has a pair of dark brown spots near the hind margin. Genitalia as in figure 5b.

Length: body, 4.5–5.5 mm.; wings, 3.5–4.0 mm.

I have examined the type in the British Museum and many specimens from numerous localities in the Hawaiian Islands as well as from Tahiti, Society Islands.

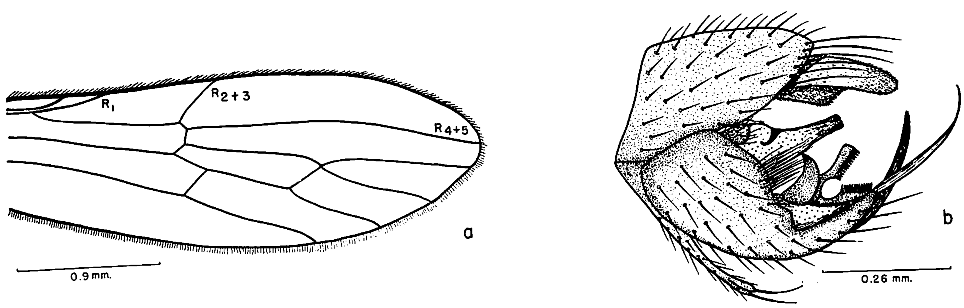

Figure 5—*Styringomyia didyma* Grimshaw: **a,** apical portion of wing; **b,** male genitalia, lateral view.

Tribe LIMONIINI Alexander

Limnobiini Brunetti, 1912, Fauna Brit. Ind. Dipt. Nematocera, p. 436.

Limoniini Alexander, 1929, Dipt. Pat. So. Chile 1:12.

Limoniinae Brues and Melander, 1932, Bul. Mus. Comp. Zool. 73:268.

Members of this tribe are easily distinguished from other crane flies in Hawaii by having the free portion of vein Cu_2 in transverse alignment with R_2 (fig. 9a) and by the very distinctive male genitalia: the very large, inflated ventral lobe of the dististylus with its rostral prolongation, bearing strong spines (figs. 6a and 8c) is especially characteristic.

One genus and two subgenera occur in Hawaii.

Genus **LIMONIA** Meigen

Amphinome Meigen, 1800, Nouv. Class. Mouch., p. 15 (a rejected name).
Limonia Meigen, 1803, Mag. für Insektenk. (Illiger), 2:262.
Limnobia Meigen, 1818, Syst. Beschr. Zweifl. Ins. 1:116. Change of name for *Limonia* Meigen because the latter name has another meaning beside that intended.

In Hawaii the members of this genus are distinguished by the characteristics given above for the tribe. Two subgenera are present: in one (*Geranomyia*) the mouthparts are greatly elongated (fig. 12d) and in the other (*Dicranomyia*) they are normal.

Type of genus: *Tipula tripunctata* Fabricius.

Subgenus **DICRANOMYIA** Stephens

Furcomyia Meigen, 1818, Syst. Beschr. Zweifl. Ins. 1:133.
Dicranomyia Stephens, 1829, Nom. Brit. Ins., p. 53; 1829, Syst. Cat. Brit. Ins. 2:243.
Glochina Meigen, 1830, Syst. Beschr. Zweifl. Ins. 6:280.
Numantia Bigot, 1854, Ann. Soc. Ent. France (3) 2:470.

Under strict application of the Rules this group would have to go under the name *Furcomyia* Meigen, since *Dicranomyia* Stephens is apparently a synonym. The Commission's recognition of the Principle of Conservation (Copenhagen Decisions, 1953:25) should give us adequate grounds for rejecting such old, long forgotten names. Edwards (1938:28) said, "*Furcomyia* is of earlier date than *Dicranomyia*, but has scarcely ever been used; *Dicranomyia* is retained here as being perhaps a permissible emendation of *Furcomyia*." I fail to see the reasoning of this latter statement. Alexander (1911:201, 1912, and 1913:487–488) used *Furcomyia* in some of his earlier works, and then changed to *Dicranomyia*. I am using the latter since it has been much more widely used in the literature.

Members of this subgenus are differentiated from other *Limonia* in Hawaii by having the mouthparts shorter than the head; by having vein R_3 ending well before the apex of the wing; by having the m crossvein nearly vertical, almost in direct alignment with and about ½ as long as the base of M_3; by having cell 1st M_2 not over two times longer than wide and not equal in length to the last

section of M_4 and also by having the m–cu crossvein placed at or slightly before the base of cell 1st M_2 (fig. 6h).

Some of the Hawaiian species have the odd habit of dancing up and down or bobbing their bodies on their long legs while in resting position in dark crevices beneath stones, in tree roots, and similar places.

The great majority of our endemic crane flies belong in this subgenus.

Type of subgenus *Dicranomyia*: by designation of Coquillett (1910:533), *Limnobia modesta* Meigen.

Type of subgenus *Furcomyia: Limonia lutea* Meigen. A monobasic genus (see Coquillett, 1910:546).

Key to the Species of Hawaiian Limonia (Dicranomyia) Based Largely upon Males.

1. Cell 1st M_2 open. Male genitalia as in figures 8d and 10b; the ventromesal lobes of the basistyli are either bifid or sharp-pointed at the apices and the spines on the rostral prolongation of each ventral basistylus are not one-third as long as the dorsal dististyli 2

Cell 1st M_2 closed (fig. 6h). Male genitalia not as above; if the ventromesal lobes of the basistyli are pointed, one or more of the spines on the prolongation of each ventral dististylus are at least half as long as the dorsal dististyli (fig. 3b) 3

2(1). Chiefly pale yellow species. The ventromesal lobe of each basistylus is distinctly bifurcate (fig. 10b). On all the major islands except possibly Lanai........ .... **swezeyi** (Alexander).

Body entirely shining black. The ventromesal lobes of the basistyli are pointed at their apices (fig. 8d). On all the major islands........ **nigropolita** (Alexander).

3(1). Ventromesal lobe of each basistylus pointed at apex (fig. 6b). Rostral prolongation of each dorsal dististylus elongate, equal in length to the width of the dististylus; at least one of the spines on the rostral prolongation is strongly developed and at least one-half as long as the dorsal dististylus. Moderately large, chiefly yellow to yellow-brown species......... 4

Genitalia not as above. Species usually marked with brown to black................................. 5

4(3). The two spines on the rostral prolongation of each ventral dististylus are both well developed and ap-

proximately equal in size (fig. 6a). On all the main islands. . . . . **grimshawi** (Alexander).

The distal spine of each set on the prolongation is very small and poorly developed, represented by just a small tubercle (fig. 6f). Molokai, Maui. . . . . **iniquispina** Hardy.

5(3). Wings without fuscous markings except for the stigma, or they may be entirely fuscous. 6

Wings with dark fuscous markings over the crossveins and at the forking of the veins. . . . . **variabilis** (Grimshaw) 5a

5a(5). Mesonotum usually dark brown. Ventromesal lobes of basistyli as in figure 11c. On all the main islands. . . . . **variabilis variabilis** (Grimshaw).

Mesonotum ochraceous except for a brown vitta running longitudinally down the middle. Ventromesal lobe as in figure 11e. Hawaii. . . . . **variabilis bryani** (Alexander).

6(5). Stigma dark brown and very prominent. Abdomen with yellow bands across the posterior margins of the segments. Pleura and sides of mesonotum yellow cinereous. The ventromesal lobes of the basistyli are enlarged at their apices; they are wedge-shaped, slightly curved on their inner margins, and densely haired (fig. 6d). On all the major islands. . . . . **hawaiiensis** (Grimshaw).

Not as above. 7

7(6). The ventral dististyli are approximately four times larger than the basistyli (figs. 8a, 9b). Larger species, body 6.0–8.0 mm. 8

The ventral dististyli are scarcely two times larger than the basistyli (figs. 7b, 7e). Smaller species, usually about 4.0 mm. in length. 10

8(7). The ventral dististyli are greatly developed and are three to four times longer than the basistyli (excluding the ventromesal lobes). The ventromesal lobes are scarcely enlarged at their apices (fig. 9c). On all the major islands. . . . . **stygipennis** (Alexander).

The ventral dististyli are approximately two times longer than the basistyli and the ventromesal lobes are rather broadly expanded and densely villose (fig. 8b). 9

9(8). Wings blackish fumose. Ventromesal lobes strongly enlarged, the apical portion is about equal in size to the main portion of the basistylus (as seen in ventral view) (fig. 8b). Mesonotum dark brown to black. Pleura and coxae brown. Maui and Molokai...... ....**kraussi** Alexander.

Wings hyaline or nearly so. Ventromesal lobe not shaped as above and about one-half the size of the main portion of the basistylus (fig. 11b). Mesonotum and pleura chiefly yellow-brown, coxae yellow. (Atypical specimens may run here.) Maui, Oahu, Hawaii......................**variabilis** (Grimshaw).

10(7). The ventromesal lobes of the basistyli are expanded at their apices (capitate) and are at least four times larger than the inner lobes (figs. 7a and 7c). Body usually brown to black and wings often fumose. Oahu, Maui, Kauai..............**jacobus** Alexander.

The ventromesal lobes are straight sided and are scarcely two times larger than the inner lobes (fig. 7f). Body (usually) chiefly or entirely yellowish.... **kauaiensis** (Grimshaw).......................10a

10a(10). Head, thorax, and abdomen uniformly pale yellow. Maui.............**kauaiensis haleakalae** Alexander.

The dorsum of the thorax and abdomen is chiefly brownish. On all the main islands................ ....**kauaiensis kauaiensis** (Grimshaw).

Limonia (Dicranomyia) grimshawi (Alexander) (figs. 6a–b).

Dicranomyia apicalis Grimshaw, 1901, Fauna Hawaiiensis 3(1):7.

Preoccupied by *Limnobia apicalis* Wiedemann (1828), a *Limonia* (*Dicranomyia*).

Dicranomyia grimshawi Alexander, 1919, Ann. Ent. Soc. Amer. 12:27.

Limonia (*Dicranomyia*) *grimshawi* (Alexander) Alexander, 1932, B. P. Bish. Mus. Occ. Pap. 9(21):6.

Endemic. Hawaii, Maui, Lanai, Oahu, Kauai. (Type series from Olaa, Hawaii and Lanai, 2,000 feet.) One of the most abundant species.

Type in British Museum (Natural History).

This is a moderately large, chiefly yellowish to yellow-brown species, readily identified by the male genital characters. The much prolonged inner lobe of each ventral dististylus is characteristic; these lobes are equal in length to the width of the dististylus and the spines on these lobes are strongly developed (fig. 6a). The ventromesal lobe of each basistylus is pointed at its apex (fig. 6b) as in *L.*

nigropolita (Alexander). The legs are pale and the femora have black rings at their apices. The wings are yellowish hyaline, the stigma light brown.

Length: body, 6.0–7.0 mm.; wings, 7.0–9.0 mm.

This species breeds in a variety of aquatic and semiaquatic habitats from decaying vegetation and dripping wet banks, to crevices in rocks submerged in mountain streams. For details of the biology and figures of the larvae and pupae see Williams (1943:317–318). The larvae feed largely on decaying plant matter but apparently upon occasions are predaceous: Williams reports "a large *grimshawi* larva devoured several pupae of *Limonia jacobus* with which it was confined." Williams said the larvae "may attain a length of 16 mm. or more" and have four finger-like caudal gills. "The pupa is about 9 mm. long. Its breathing horns differ from those of *L. perkinsi* in being rounded rather than triangular or wedge shaped. Under water these organs have a golden air-filled appearance with the distal margin finely beaded with silver."

Limonia (Dicranomyia) hawaiiensis (Grimshaw) (figs. 6c–e).

Dicranomyia hawaiiensis Grimshaw, 1901, Fauna Hawaiiensis 3(1):7. Alexander, 1919, Ann. Ent. Soc. Amer. 12:28.

Dicranomyia latifrons Grimshaw, 1901, Fauna Hawaiiensis 3(1):9. **New synonymy**? See note below.

Limonia (*Dicranomyia*) *casei* Alexander, 1941, Proc. Haw. Ent. Soc. 11:23. **New synonymy**, see note below.

Endemic. On all the major islands. (Type series from: Hilo, 2,000 feet; Kahoiluamano, Kauai; Molokai Mts., 3,000–4,500 feet; and Haleakala, Maui, 5,000 feet.)

Type in the British Museum (Natural History).

Dicranomyia latifrons Grimshaw was based on a single male specimen taken at Waialua, Oahu, 1893. From the original description it appears to differ from *L. hawaiiensis* by having the antennae chiefly yellow and the stigma very pale. I suspect that this could have been a teneral specimen. I have seen individuals in the *hawaiiensis* series which fit this description. The true status of *latifrons* cannot be ascertained without studying the male genitalia of the type.

This species is very common throughout the Islands, especially in the lowlands. It is easily recognized by the conspicuous stigma in the wings; by the yellowish cinereous pleura and sides of mesonotum and the brown notum; by the broad yellow bands at the apices of the abdominal segments; and by the distinctive shape of the ventromesal lobes of the basistyli (fig. 6d). The legs are usually predominantly brownish but the coloration varies considerably. Typically the femora are yellow-brown on their basal halves and darker brown toward the apices but with the extreme apices yellow. They vary from this condition to that where the femora are all yellow except for a slightly brownish area before the apices. This is the character upon which *L. casei* was based and it appears to fall within the normal range of variation for the species.

I have studied a paratype of *L. casei* Alexander (Lulumahu Stream, Oahu) in the Hawaiian Sugar Planters' Association collection and metatypes (Honolulu, Oahu; and Olinda, Maui) from Alexander's collection. The type is supposed to be in the H.S.P.A. collection but was not found there. Alexander in his original description says *L. casei* is "most similar to *Limonia* (*Dicranomyia*) *hawaiiensis* (Grimshaw) differing especially in the coloration of the body, legs, and wings." I have not been able to see significant differences in the specimens which I have studied. In the large series of specimens at hand there are many individuals which fit *casei* but for the most part they appear to be teneral. The male genitalia of the metatypes are like those of typical *hawaiiensis*.

Length: body, 6.0–7.0 mm.

Limonia (Dicranomyia) iniquispina Hardy (figs. 6f–h).

Limonia (*Dicranomyia*) *iniquispina* Hardy, 1953, Proc. Haw. Ent. Soc. 15:55.

Endemic. Molokai and Maui. (Type locality: Puu Kolekole, Molokai, 4,000 ft.)

Type in the United States National Museum.

This species is closely related to *L. grimshawi* (Alexander) and is distinguished by the male genital characters. The presence of but one strong spine on the prolongation of each ventral diststylus will best differentiate it (fig. 6f). The differences in the shapes of the ventromesal lobes of the basistyli and the posterior margin of the ninth tergum as shown in figures 6f and 6g are also significant.

Length: body, 6.0–7.0 mm.; wings, 8.0–9.0 mm.

Limonia (Dicranomyia) jacobus (Alexander) (figs. 7a–c).

Dicranomyia jacobus Alexander, 1919, Ann. Ent. Soc. Amer. 12:28.

Limonia (*Dicranomyia*) *jacobus* (Alexander) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):7; 1941, Proc. Haw. Ent. Soc. 11:23.

Endemic. Maui, Kauai, Oahu. (Type locality: Iao Valley, Maui, 700 feet.)

Type in Alexander's collection.

This species is closely allied to *Limonia* (*Dicranomyia*) *kauaiensis* (Grimshaw) and is best distinguished by the male genital characters. The typical specimens are darker in color than *kauaiensis* (body brown to blackish) and the wings are light brownish fumose. Specimens are often seen, however, which have the body pale and the wings hyaline. The ventromesal lobes of the basistyli are expanded, capitate at their apices in *jacobus* (fig. 7a); in *kauaiensis* they are straight sided or nearly so (fig. 7d).

I have studied a paratopotype and a metatype from Alexander's collection and also a large series from numerous localities on Oahu, Kauai, and Maui (including the type locality). This is one of the commonest Hawaiian crane flies along the mountain streams. Williams found the immature stages of this species developing in the algae growth on rocks in mountain streams on Oahu. For details of the biology and figures of the larvae and pupae see Williams (1943:318–321).

Length: body, 4.0–5.0 mm.; wings, 5.0–6.5 mm.

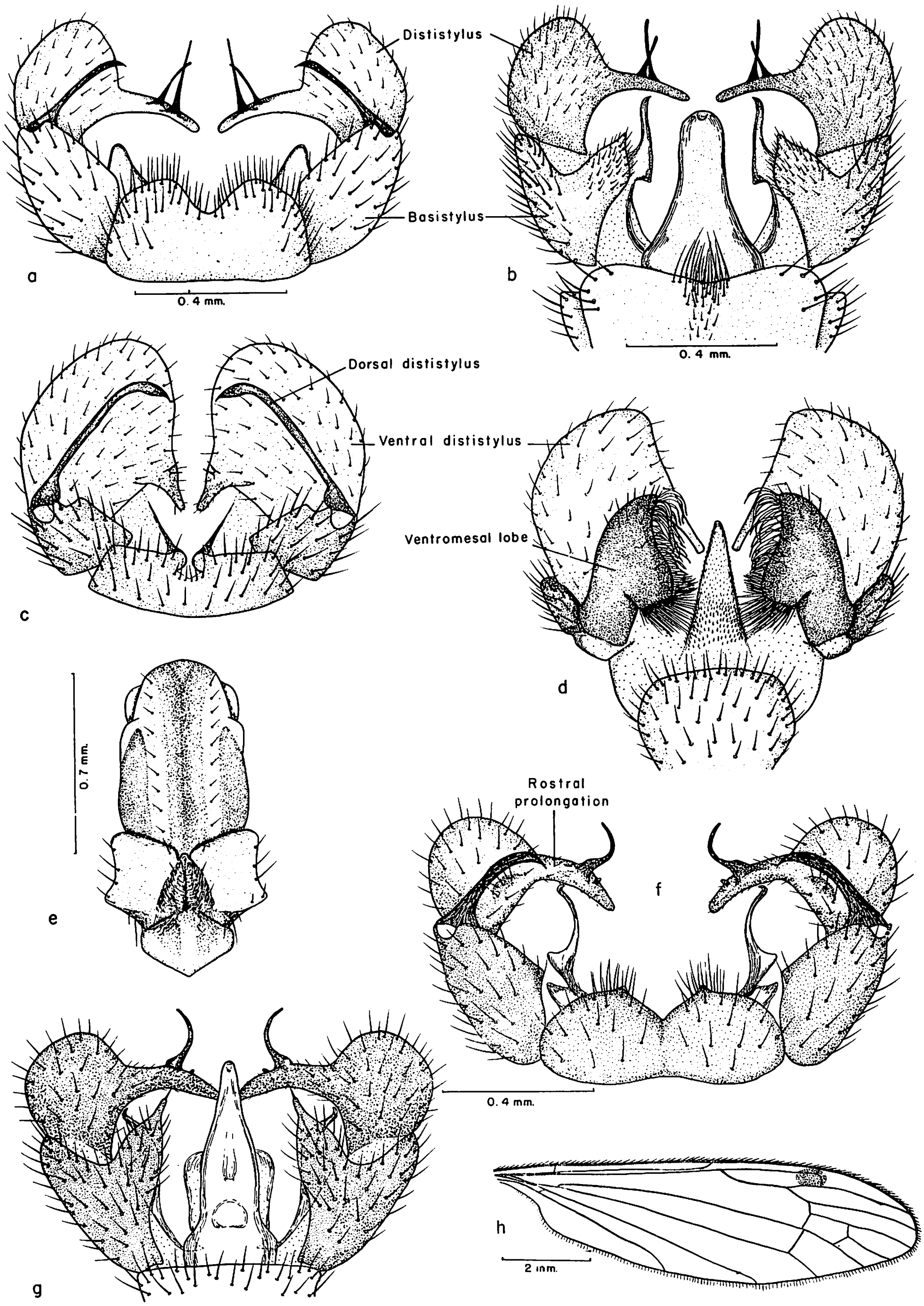

Figure 6—*Limonia* (*Dicranomyia*) *grimshawi* (Alexander): **a,** male genitalia, dorsal view; **b,** male genitalia, ventral view. *L.* (*Dicranomyia*) *hawaiiensis* (Grimshaw): **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view; **e,** mesonotum, dorsal view. *L.* (*Dicranomyia*) *iniquispina* Hardy: **f,** male genitalia, dorsal view; **g,** male genitalia, ventral view; **h,** wing.

Limonia (Dicranomyia) kauaiensis (Grimshaw) (figs. 7d–e).

Dicranomyia kauaiensis Grimshaw, 1901, Fauna Hawaiiensis 3(1):8.

Dicranomyia foliocuniculator Swezey, 1915, Proc. Haw. Ent. Soc. 3:87. Alexander, 1919, Ann. Ent. Soc. Amer. 12:28. **New synonymy.**

Limonia (Dicranomyia) foliocuniculator (Swezey) Alexander, 1932, B. P. Bishop Mus. Occ.Pap. 9(21):6.

Limonia (Dicranomyia) kauaiensis (Grimshaw) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):7.

Endemic. On all the main Islands (type labeled "Kauai," 4,000 ft.).

Type in the British Museum (Natural History).

The type of *foliocuniculator* is in the Hawaiian Sugar Planters' Association collection. (Type locality: Punaluu, Oahu.)

The type locality of *L. kauaiensis* (Grimshaw) is unknown. The type was apparently labeled just "Kauai, 4,000 ft., Oct. 1895." The species here considered to be *kauaiensis* is the only one I have seen from Kauai which fits Grimshaw's description. I have seen specimens from numerous localities in the mountains on that island and my concept of this species is probably correct. I have studied the type of *foliocuniculator* (Swezey), also paratypes, topotypes, and numerous specimens from many localities on Oahu, and can find no structural characters which will distinguish it from *kauaiensis.*

L. kauaiensis is a moderately small species, rather variable in coloration. The specimens are typically yellowish to yellow-brown with the dorsum of the thorax and abdomen brownish. The abdomen (in the field) is often greenish in color, especially in female specimens. The details of the male genitalia, especially those of the mesoventral lobes of the basistyli, will differentiate this species (figs. 7d and 7e).

This species is unique in the family Tipulidae because of its leaf-mining habits. It has been recorded mining the leaves of *Cyrtandra paludosa* Gaud. and other species of this genus. Alexander has suggested (1919:28) that other Hawaiian species such as *L. jacobus* and *L. swezeyi* may also be leaf miners.

This is one of the most common species taken in vegetation in the mountains on some of the Islands. I have seen specimens from numerous localities on Kauai, Oahu, and Maui. For details of its biology and figures of the different stages and the mine see Swezey (1915:87–89).

Length: body, 3.0–4.0 mm.; wings, 4.5–5.5 mm.

Limonia (Dicranomyia) kauaiensis haleakalae Alexander, **new combination** (fig. 7f).

Limonia (Dicranomyia) haleakalae Alexander, 1951, Ann. Mag. Nat. Hist. Ser. 12, 4(42):583.

Endemic. Maui. (Type locality: Paliku, within the crater of Haleakala, 6,500 feet.)

Type in Alexander's collection.

I have been unable to find any structural details by which I could separate *L. haleakalae* from *kauaiensis* and it appears that this should be treated as a subspecies. It is distinguished from the typical form by its uniformly yellow head, thorax, and abdomen. In this regard it resembles the paler specimens of *L. swezeyi* (Alexander); but the 1st M_2 cell is closed and the genitalia are very different (fig. 7f). The subspecies *haleakalae* also is slightly larger than *kauaiensis;* the average wing length is 6.0 mm. as compared to 5.0 mm.

I have studied the type, a paratype, and a series of specimens taken at the type locality, June-August, 1952 (D. E. Hardy and W. C. Mitchell).

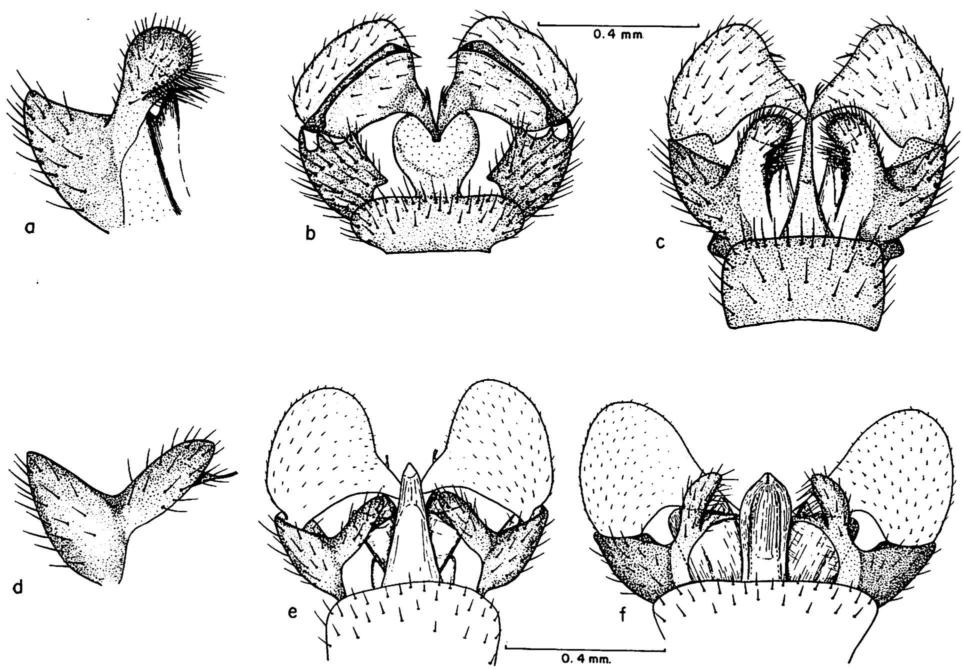

Figure 7—*Limonia* (*Dicranomyia*) *jacobus* (Alexander): **a,** ventromesal lobe; **b,** male genitalia, dorsal view; **c,** male genitalia, ventral view. *L.* (*Dicranomyia*) *kauaiensis* (Grimshaw): **d,** ventromesal lobe; **e,** male genitalia, ventral view. *L.* (*Dicranomyia*) *kauaiensis haleakalae* Alexander: **f,** male genitalia, ventral view.

Limonia (Dicranomyia) kraussi Alexander (figs. 8a–b).

Limonia (*Dicranomyia*) *kraussi* Alexander, 1951, Ann. Mag. Nat. Hist. Ser. 12, 4(42):584.

Endemic. Maui and Molokai. (Type locality: Olinda, Maui; paratypes from Paliku, within the crater of Haleakala, 6,500 feet.)

Type in Alexander's collection.

This species is very close to *L. stygipennis* (Alexander) and can be distinguished only by male genital characters. The ventral dististyli are not so greatly developed as in *stygipennis;* they are about two times longer than the basistyli (fig. 8a), not three to four times longer (fig. 9b). The ventromesal lobe is broadly expanded at its apex (fig. 8b), while in *stygipennis* it is scarcely enlarged (fig. 9c).

The body is typically brownish to black with a slight reddish brown tinge in the ground color, especially on the pleura. The wings are usually blackish fumose.

Length: body, 7.0–8.0 mm.; wings, 7.5–9.0 mm.

I have examined the holotype (Olinda, Maui) and two paratypes from Paliku, Haleakala crater, 6,500 feet, and also a large series of specimens from the latter locality, June, 1952 (D. E. Hardy and M. Tamashiro); this species is very abundant in the Paliku area.

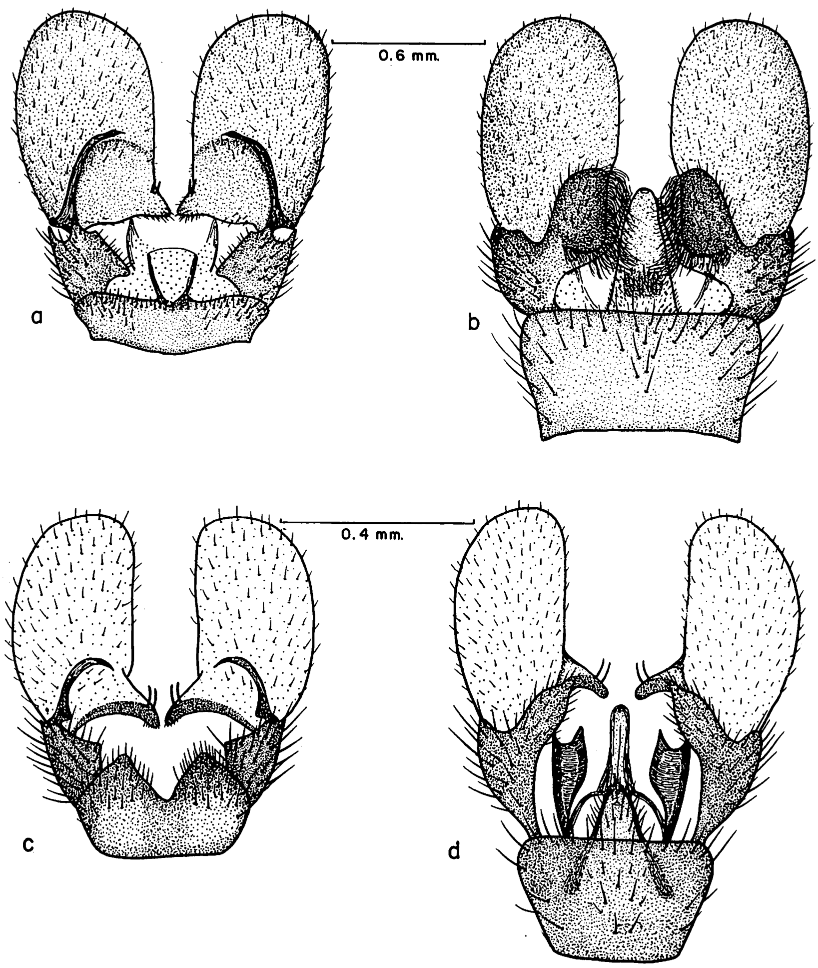

Figure 8—*Limonia (Dicranomyia) kraussi* Alexander: **a,** male genitalia, dorsal view; **b,** male genitalia, ventral view. *L. (Dicranomyia) nigropolita* (Alexander): **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view.

Limonia (Dicranomyia) nigropolita (Alexander) (figs. 8c–d).

Dicranomyia nigropolita Alexander, 1923, Proc. Haw. Ent. Soc. 5:250.

Limonia (Dicranomyia) nigropolita (Alexander) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):7.

Endemic. On all the major Islands. (Type locality: Kaunahona, Maui. Allotype and paratypes from southeast Koolau Mountains, Oahu; Wahiawa, Oahu; and Waihee, Maui.)

Type in P. B. Bishop Museum, Honolulu.

This species is readily distinguished by its typically shining black coloration; the silver front; by the open cell 1st M_2 in the wing and by the distinctive genitalia as shown in figures 8c and 8d.

Length: body, 3.0–4.0 mm.; wings, 4.0–4.8 mm.

I have studied the type and allotype and numerous specimes from many localities throughout the Islands. The species is usually taken in the mountains in dense vegetation.

Limonia (Dicranomyia) stygipennis (Alexander) (figs. 9a–c).

Dicranomyia brunnea Grimshaw, 1901, Fauna Hawaiiensis 3(1):8.

Dicranomyia stygipennis Alexander, 1919, Ann. Ent. Soc. Amer. 12:27; 1923, Proc. Haw. Ent. Soc. 5:250.

Limonia (Dicranomyia) stygipennis (Alexander) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):7. New name for *D. brunnea* Grimshaw (1901), preoccupied by *D. brunnea* Doane (1900).

Type (of *D. brunnea*) in British Museum (Natural History).

Endemic. On all the major Islands, except possibly Lanai, for which we have no records. (Type series of *brunnea* from Hilo, Hawaii, 2,000 feet; Kona, Hawaii, 2,000–4,000 feet; Koholuamano, Kauai, 4,000 feet; Haleakala, Maui, 5,000 feet; Kahanui, Molokai; and Pelekunu, Molokai.)

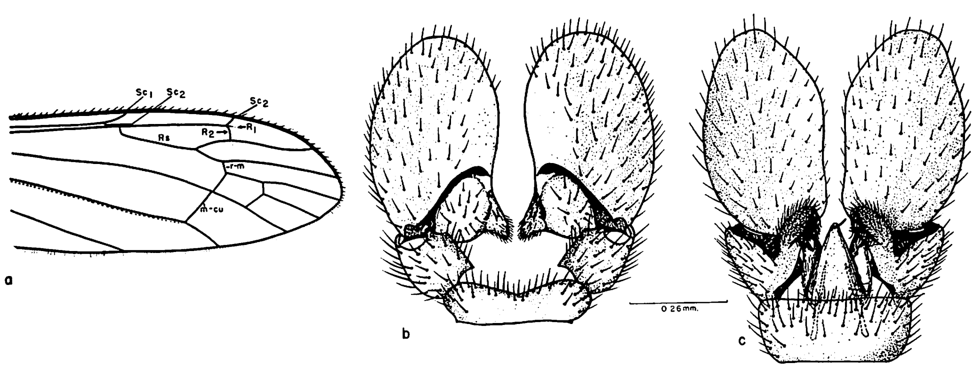

Figure 9—*Limonia (Dicranomyia) stygipennis* (Alexander): **a,** apical portion of wing; **b,** male genitalia, dorsal view; **c,** male genitalia, ventral view.

L. stygipennis is apparently close to *L. fullawayi* (Alexander), described from the island of Guam, Mariana (Ladrone) Islands, and Caroline Islands. The rostral prolongation of the ventral dististylus is not so slender in *stygipennis;* see figures 9b and 9c and Alexander (1915:79;1940:210).

This species is the largest and one of the most abundant of the Hawaiian crane flies. It is common along mountain streams where the adults are found hiding beneath large rocks or under overhanging banks. The species is characterized by the great development of the ventral dististyli of the male genitalia; these structures are three times longer than the basistyli (fig. 9b). The ventromesal lobe of the basistylus is also characteristic in shape (fig. 9c).

The specimens are typically all black with smoky to black fumose wings. Often specimens which have the wing hyaline or just slightly fumose are seen. Grimshaw described the wings as being hyaline. Alexander assumed his *stygipennis* to differ from *brunnea* Grimshaw because of the fumose wings. The body is often brown and the thorax is sometimes rufous tinged, especially on the pleura.

Length: body, 7.0–9.0 mm.; wings, 8.1–10.0 mm.

Limonia (Dicranomyia) swezeyi (Alexander) (figs. 10a–b).

Dicranomyia swezeyi Alexander, 1919, Ann. Ent. Soc. Amer. 12:29.

Limonia (Dicranomyia) swezeyi (Alexander) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):7.

Limonia (Dicranomyia) wainaensis Alexander, 1951, Ann. Mag. Nat. Hist. Ser. 12, 4(42):586. Emended to *waianaensis* by Hardy 1952, Proc. Haw. Ent. Soc. 14:445. **New synonymy** based upon a comparison of the types of both species and upon a study of a large series of specimens from both the Waianae and the Koolau mountains.

Endemic. Rather common on all the major Islands, except possibly Lanai. (Type locality: Mt. Olympus, Oahu.)

Type in the collection of the Hawaiian Sugar Planters' Association.

A moderately small, predominantly pale, species characterized by the open cell 1st M_2 and by the distinctive shape of the ventromesal lobes of the male genitalia (fig. 10b). This lobe is distinctly bifurcate and is not so shaped in any other known Hawaiian species. Typical specimens have the thorax chiefly yellow, with a broad, pale brown stripe down the middle of the dorsum. The original description of *L. waianaensis* says the scutum is blackened medianly (in the holotype it appears to be dark brown to blackish). Specimens at hand vary from this condition to entirely yellow. I have seen some differences (apparently variations) in the shape of the arms of the ventromesal lobes; in the length of the prolongations of the ventral dististyli; and in the position of the strong setae on the dististyli. But, when compared through a long series of specimens, the differences do not appear to be significant.

This species is always taken in dense vegetation and it very possibly is a leaf miner.

Length: body, 2.8–4.5 mm.; wings, 3.8–5.0 mm.

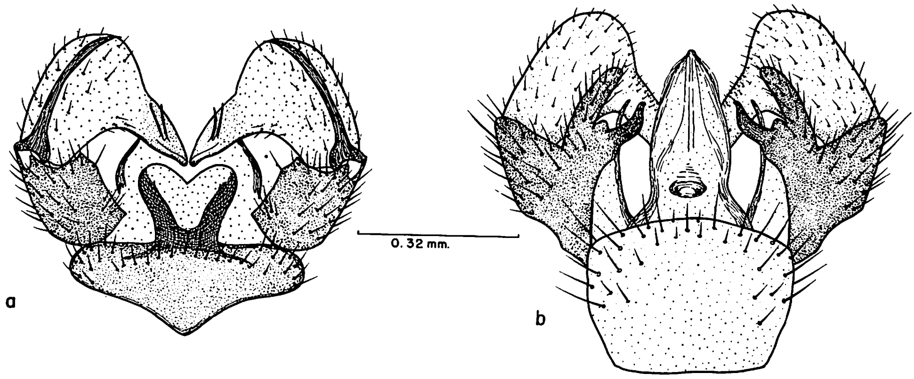

Figure 10—*Limonia* (*Dicranomyia*) *swezeyi* (Alexander): **a,** male genitalia, dorsal view; **b,** male genitalia, ventral view.

Limonia (Dicranomyia) variabilis (Grimshaw) (figs. 11a–c).

Dicranomyia variabilis Grimshaw, 1901, Fauna Hawaiiensis 3(1):8.

Limonia (*Dicranomyia*) *variabilis* (Grimshaw) Alexander, 1932, B. P. Bishop Mus. Opp. Pap. 9(21):7.

Endemic. Maui, Hawaii, and Oahu. (Type locality: Haleakala, Maui, 5,000 feet.) This is very common in the mountains of some of the Islands.

Type in British Museum (Natural History).

This species is related to *L. kraussi* (Alexander) and is differentiated by the more hyaline wings with brownish infuscations on the crossveins and the forks of the veins; by its typically paler coloration, and by the male genital characters (figs. 11a and 11b), especially the development of the ventromesal lobes of the basistyli. The pleura and sides of the mesonotum are yellow-brown in ground color and are densely yellowish pollinose. The top of the mesonotum and most of the abdomen is brown; the eighth abdominal segment is usually predominantly yellowish. The coxae are yellow. The wing maculations are not always present (especially in teneral specimens), and the male genitalia must be relied upon for identification.

Length: body, 6.0–7.0 mm.; wings, 7.5–9.3 mm.

Limonia (Dicranomyia) variabilis bryani (Alexander), **new combination** (figs. 11d–e).

Dicranomyia bryani Alexander, 1924, Ann. Mag. Nat. Hist. Ser. 7, 13:35.

Limonia (*Dicranomyia*) *bryani* (Alexander) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):6.

Endemic. Hawaii (type locality: 29 Miles, Olaa, Hawaii).

Type apparently in C. P. Alexander's collection. It is supposed to be in the B. P. Bishop Museum, according to the original description.

I have not seen the type of this species but specimens on hand from Kilauea, Hawaii, fit the original description in all details. I find no characters which will

clearly differentiate it from *L.* (*Dicranomyia*) *variabilis* (Grimshaw) and it appears to be a synonym or, at most, a subspecies of this. The ventromesal lobes of the basistyli appear to be slightly more enlarged in *bryani* than in typical *variabilis* (fig. 11e) and the inner lobes of the basistyli are more densely setose. The mesonotum of typical *variabilis* is dark brown (but showing considerable variation), while in *bryani* it is chiefly ochraceous with a brown vitta extending longitudionally down the middle.

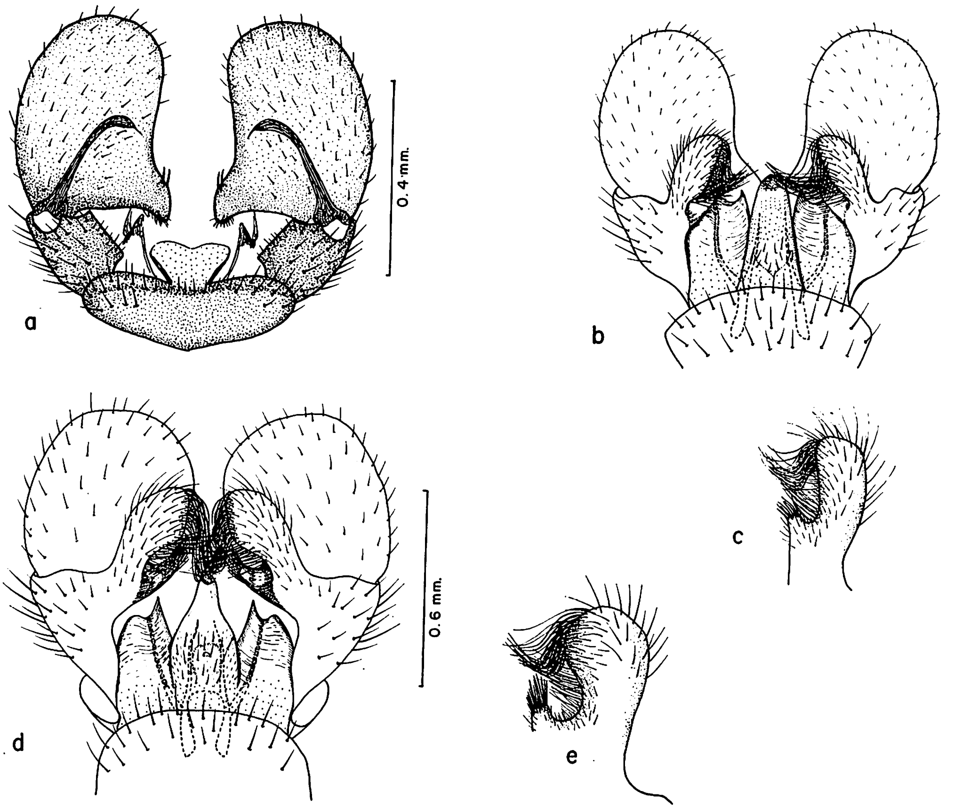

Figure 11—*Limonia* (*Dicranomyia*) *variabilis* (Grimshaw): **a,** male genitalia, dorsal view; **b,** male genitalia, ventral view; **c,** ventromesal lobe. *L.* (*Dicranomyia*) *variabilis bryani* (Alexander): **d,** male genitalia, ventral view; **e,** ventromesal lobe.

Subgenus **GERANOMYIA** Haliday

Geranomyia Haliday, 1833, Ent. Mag. 1:154.

This subgenus differs from *Limonia* (*Dicranomyia*) by having the mouthparts elongated—at least as long as the head and thorax combined (fig. 12d). This prolongation is made up of the greatly elongated labial palpi rather than being an extension of the front of the head (nasus) with the reduced mouthparts located at the extreme tip as they are in the genera *Elephantomyia* and *Toxorhina*.

The adults of *Geranomyia* feed on the nectar of flowers.

Just one species is known from Hawaii.

Type of subgenus: *Geranomyia unicolor* Haliday.

Limonia (Geranomyia) advena Alexander (figs. 12a–f).

Limonia (*Geranomyia*) *advena* Alexander, 1954, Proc. Haw. Ent. Soc. 15:297.

Endemic? Oahu (type locality: Honolulu), and Kauai.

Type in the U. S. National Museum.

This species apparently occupies a tremendous range of habitats in the Islands. It is often seen at lights in the lowlands on Oahu. The adults have been collected and the larvae found breeding in a brackish water (stagnant) canal on the south coast of Kauai and also breeding in moss under the waterfalls in the mountains

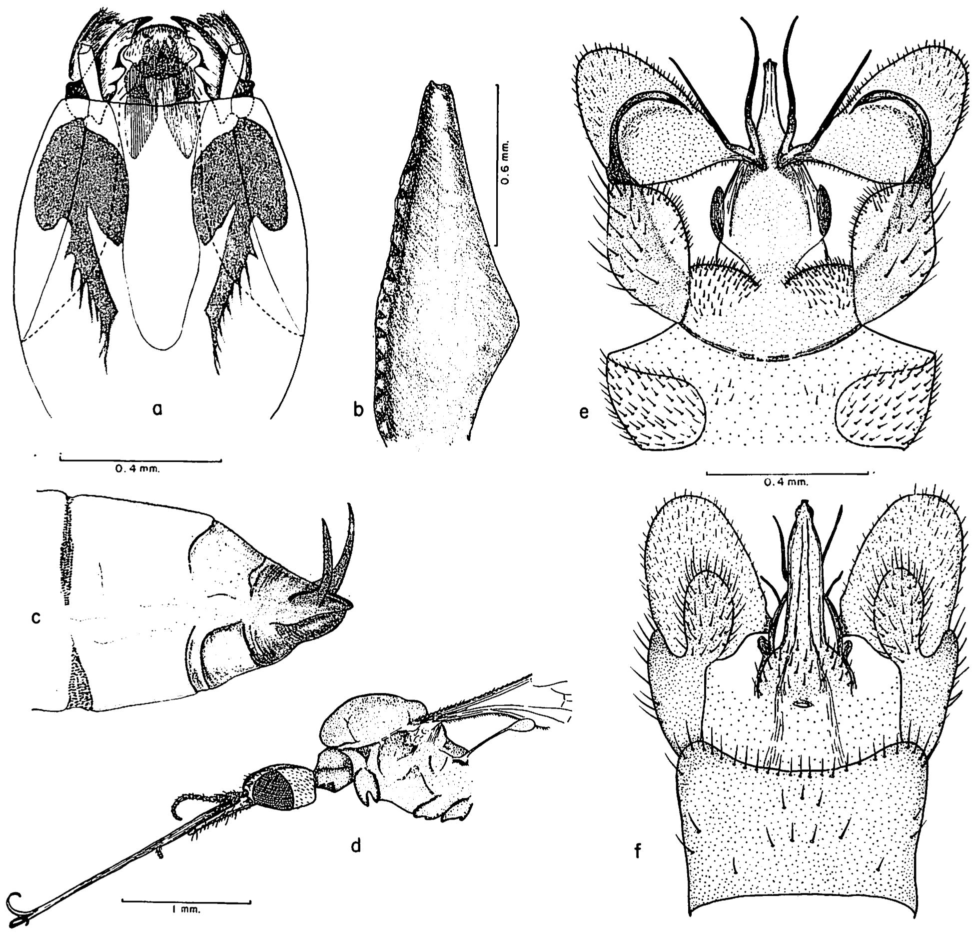

Figure 12—*Limonia* (*Geranomyia*) *advena* Alexander: **a,** larval head, dorsal view; **b,** anterior breathing horn of pupa; **c,** posterior end of pupa, lateral view; **d,** adult head; **e,** male genitalia, dorsal view; **f,** male genitalia, ventral view.

of Kauai at elevations of around 4,000 feet. The larvae are found enmeshed in the moss under the falls, with only their posterior portion protruding. The full-grown larvae measure about 14 mm. in length and are dirty white in color. I see no evidence of gills; the tracheal trunks open directly to the exterior. The head is inverted into the thoracic segments, it is heavily sclerotized, and the parts are as in figure 12a. The pupae have a pair of very strong dorsal hooks on the posterior end (fig. 12c) and the breather horns are large, rather elongate-triangular (fig. 12b).

The adults are readily distinguished from all other Hawaiian crane flies by the elongated mouthparts (fig. 12d) and by the male genitalia, as shown in figures 12e and 12f. The thorax is dull yellow, tinged with brown, with three broad brown vittae down the mesonotum. The wings are hyaline and the venation rather similar to that of other *Limonia* in Hawaii. The r–m crossvein is almost obliterated by the fusion of veins R_{4+5} and M_1 at their bases. Crossvein m–cu is in direct alignment with the transverse basal section of M_{1+2}. The abdominal terga are brown with narrow yellow apices, the sterna are yellow.

Length: body, excluding the rostrum, 5.5–7.5 mm.; wings, 5.5–8.5 mm.; rostrum, 2.5–4.0 mm.

I believe it most improbable that this is a native species. Alexander said it is related to *L. (Geranomyia) canadensis* (Westwood), which ranges from Canada to Argentina; it is probable that *L. advena* has been introduced into the Islands rather recently. The earliest collection date is January, 1952, but it probably was here for some time before that.

Subgenus **LIBNOTES** Westwood

Libnotes Westwood, 1876, Trans. Ent. Soc. Lond., p. 505.

This subgenus is distinguished from other Hawaiian *Limonia* by the strongly arched vein R_3; by the elongate cell 1st M_2; by the position of the m–cu crossvein; and by having the m crossvein in alignment with the apical section of vein M_3 and about two times longer than the basal section of M_3 (fig. 13a). Vein R_3 curves downward and ends at or below the apex of the wing. Cell 1st M_2 is about four times longer than wide and the m–cu crossvein is situated at about the basal two-fifths of this cell. Each tarsal claw has a strong tooth at its base.

Type of subgenus: *Libnotes thwaitesiana* Westwood.

Limonia (Libnotes) perkinsi (Grimshaw) (figs. 13a–c).

Limnobia perkinsi Grimshaw, 1901, Fauna Hawaiiensis 3(1):6.

Libnotes perkinsi (Grimshaw) Alexander, 1919, Ann. Ent. Soc. Amer. 12:26.

Limonia (Libnotes) perkinsi (Grimshaw) Alexander, 1932, B. P. Bishop Mus. Occ. Pap. 9(21):6.

On all the major Islands. (Type series from Kona, 2,000–3,000 feet, and Honolulu.)

Very common, especially at lower elevations.

Immigrant. Recorded from Marquesas, Fiji, Society Islands, Tahiti, and Samoa.

Type in the British Museum (Natural History).

This species is readily recognized by the strongly arched vein R_3, by the elongate cell 1st M_2, and by the spotting of the wings as shown in figure 13a. The chiefly yellow legs with broad black apices of the femora, the yellow sternum of the thorax and venter of the abdomen, as well as the genital characters as shown in figures 13b and 13c, will also help to differentiate this species. In the male, each tarsal claw has a strong tooth at its base below; in the female this is developed into a moderately strong bristle-like structure.

Williams found the larvae to be highly adaptable: "in dry weather it may develop in humus or in damp decaying wood or with sufficient rainfall, live under aquatic or semiaquatic conditions." He says it breeds commonly in tree holes, leaf axils, and decaying vegetation. For biological details and figures of the immature stages, see Williams (1943:314, 316, 319, and 321).

Length: body, 4.0–5.0 mm.; wings, 5.0–7.0 mm.

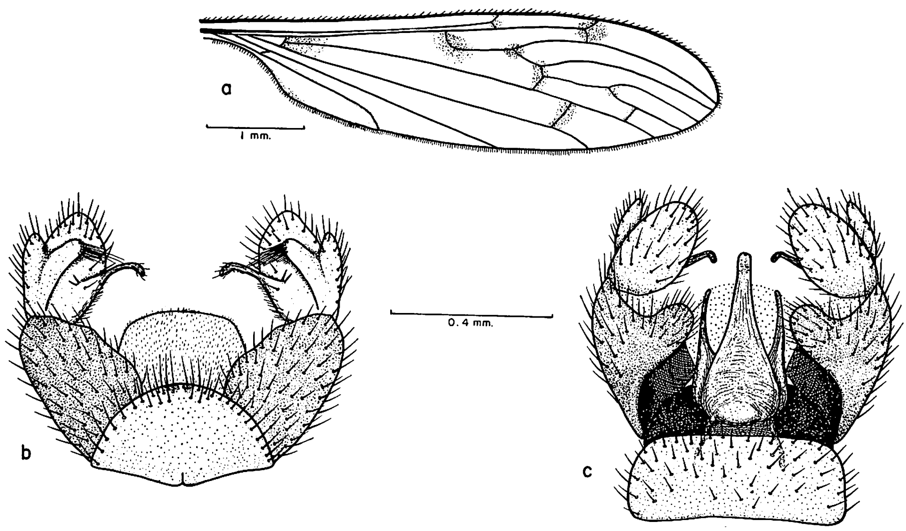

Figure 13—*Limonia* (*Libnotes*) *perkinsi* (Grimshaw): **a,** wing; **b,** male genitalia, dorsal view; **c,** male genitalia, ventral view.

Family Psychodidae Newman
Moth Flies

Psychodites Newman, 1834, Ent. Mag. 2:388.

Psychodides Zetterstedt, 1837, Oken's Isis 1837, p. 61.

Phlebotomidae Walker, 1851, Ins. Brit. Dipt. 1:7.

Phalenoidae Bigot, 1852, Ann. Soc. Ent. France (2) 10:484.

Psychidae Bigot, 1853, Ann. Soc. Ent. France (ser. 3) 1:310, 311 (a correction of Phalenoidae Bigot, 1852).

Psychodidae Bigot, 1853, Ann. Soc. Ent. France (ser. 3) 2:466.

Given as "Psycholidae" on p. 477. The error Psycholidae was corrected in Bul. Soc. Ent. France for 1854, p. 76.

Phlaebotomidae Rondani, 1856, Dipt. Ital., Parma 1:16.

Phloebotomidae Rondani, 1856, Dipt. Ital., Parma 1:37.

For more complete synonymy under the family name see Handlirsch, in Schröder (1925:966).

These densely haired little midges are rather moth-like in appearance and are commonly called moth flies. They are sometimes referred to as owl midges. The blood-sucking members of the family (none present in Hawaii) are known as sand-flies. The name of the type genus is from the Greek and refers to the moth-like appearance (psyche, soul; a butterfly as an emblem of the soul, plus eidos, form; form like a moth or butterfly).

The psychodids are small delicate flies characterized by their thickly haired body and wings; by their distinctive wing venation with many longitudinal veins or branches reaching the wing margin and with inconspicuous crossveins situated near the bases of the wings (fig. 15a); by their habit of holding the wings roof-like over the body when at rest; and by their peculiar short jerky flights. The wings are broad rather than ovate in most species and are often clothed with scales. The microscopic characteristics of the genitalia of both sexes, the antennae, the mouth-parts, and the wing venation are useful in separating the species; but it is necessary to prepare slide mounts in order to identify them. The family has been very poorly known in the past and, until the classification was placed upon a firm foundation by Tonnoir (1919 to 1940) (also an important contribution by Del Rosario, 1936), the group was in a chaotic state and it was possible to name but a few of the species accurately. The modern students of this family, Drs. G. H. Satchell (1950, 1953) (New Zealand), L. W. Quate (1954, 1955) (North America), G. B. Fairchild (Panama), and the late Dr. Sven Berden (Sweden), have made tremendous advancements in straightening out the taxonomy of this family. The Hawaiian fauna was almost completely unknown until Quate's revision of our species (1954). He keyed, described, and figured 14 species for the Hawaiian Islands; six of these are apparently endemic (*Trichomyia hawaiiensis* Quate, *T. oahuensis* Quate, *Psychoda wirthi* Quate, *P. hardyi* Quate, *P. williamsi* Quate, and *P. uncinula* Quate). Of the other species, *Telmatoscopus albipunctatus* (Williston) and *Psychoda alternata* Say are cosmopolitan in distribution. *Psychoda inornata* Grimshaw is also widely distributed and is common in North America, Europe, New Zealand, Australia, and probably elsewhere; *P. pseudalternata* Williams occurs also in Australia and New Zealand; *P. harrisi* Satchell is widely distributed in Australasia; *P. rarotongensis* Satchell is also known from the Society Islands, Cook Islands, southern United States, the West Indies, and Algeria. *P. salicornia* Quate also occurs in California, and *P. insulicola* Quate has recently been taken in Georgia and Alabama (see Quate, 1955:225).

The adults of these flies are attracted to lights in large numbers and occur commonly in the vicinity of water and in the rank vegetation along wet mountain trails. *Psychoda alternata* Say and *pseudalternata* Williams are our most domestic species; they breed in a very wide variety of situations from sewer beds and drainpipes to all sorts of aquatic environments where decaying organic matter is present. These species sometimes invade houses in large numbers and may become a nuisance.

Because of their delicate nature the psychodids must be collected and handled with great care. It is often difficult to get them into collections in suitable condition for identification. They are easily collected by trapping at light, sweeping vegetation, or by aspirating from the foliage. They should not be placed in killing jars and left to rattle around with other insects since their hairy vestiture is easily rubbed off and often the antennae and other appendages are broken. Satchell (1953a:360) says psychodids should be "taken home alive, killed with ammonia fumes and pinned on fine points immediately." Quate (1955:106) indicates that it is not good practice to "allow the adults to stay alive in the bottle very long because their movements quickly denude them and may break off their delicate appendages." Apparently the most satisfactory way of handling them is to kill them as soon as possible after collecting and carefully layer them in pill boxes between layers of cellucotton. The essential point is that specimens should be mounted (preferably on minuten nadeln) as soon as possible after they are collected. Quate recommends having a series of both pinned and alcoholed (70 percent) specimens; the latter are the more important for purposes of classification. It is impossible to identify most species without using slide mounts. Quate (*loc. cit.*) recommends mounting in euparal (diaphane) after clearing in 10 percent potassium hydroxide and dehydrating in methyl cellosolve. Satchell prepares his specimens in balsam.

For a thorough discussion of morphology and terminology refer to Quate (1955:108–114). The terminology of the wing venation used by Quate is after Tonnoir (1935), following the Comstock-Needham terminology. The anterior fork in the wing is the bifurcation of vein R_{2+3} and the hind fork is the bifurcation of M_{1+2}. According to Fairchild (1955:183), veins R_2 and R_3 are fused in Trichomyiinae so the bifurcation of radius is made up of R_{2+3} and R_4 (see discussion under genus *Trichomyia*). The following terminology of the genitalia is quoted from Quate (1954:336):

> The female subgenital plate is the ninth sternite situated ventrad of the ovipositors or cerci. The appendages of the male genitalia are termed the surstyli and coxites. After rotating through 180° the surstyli are the ventral appendages and usually bear at their tips one or more spatulate or otherwise modified bristles, termed tenaculae. The coxites are the dorsal appendages after rotation and are composed of a proximal basistyle and apical dististyle. The aedeagus originates within the eighth segment and passes posteriorly at the level of the base of the coxites. It is highly variable in structure and may be a simple shaft or an asymmetrical, multipartite structure. The ninth tergite is a broad, quadrate plate ventrad to the coxites and aedeagus. The surstyli arise from its posterior lateral corners.

In Hawaii this family is of no apparent importance other than that it may perhaps cause a nuisance when immerging from drainpipes in large numbers or

when attracted into houses by lights. In other parts of the world various species of the genus *Phlebotomus* are very important disease vectors. They transmit certain disease-carrying viruses, and *Bartonella* and *Leishmania* organisms.

Some of the psychodids are among the most primitive of Diptera, and genera such as *Nemopalpus* and *Bruchomyia* are obviously close to the basic stock from which the order Diptera arose.

The biologies of several Hawaiian species have been rather carefully studied by Williams (1943).

Key to Subfamilies and Genera of Psychodidae Found in Hawaii

1. Radius with five branches (two longitudinal veins present between the bifurcations of R_{2+3} and M_{1+2}) (fig. 15a). Eye bridge present on upper part of front (fig. 16e). Palpi four-segmented. Flagellar segments of antennae barrel-shaped or nodiform. **Psychodinae** 2

   Radius four-branched (only one vein between bifurcations of radial and medial veins) (fig. 14c). Eyes round, no bridge present (fig. 14a). Palpi three-segmented. Flagellar segments elongate pyriform or subcylindrical. **Trichomyiinae** .... **Trichomyia** Curtis.

2. Apical segments of antennae not reduced in size and each has a long slender apiculis (fig. 15c). Large species, wings 2.6–3.8 mm., with predominantly dark vestiture and conspicuous patches of white scales at tips of veins...... .... **Telmatoscopus** Eaton.

   Antennae with one to three apical segments reduced in size, about half the size of the preceding segments and without apiculis (fig. 17j). Moderate to small species. Vestiture usually uniformly yellowish or pale in color. No conspicuous patches of white scales on wings and wings never densely brown to black haired........ **Psychoda** Latreille.

Subfamily Trichomyiinae Tonnoir

Phlebotominae Eaton, in part, 1895, Ent. Mo. Mag. Ser. 2, 6:210.
Trichomyinae Tonnoir, 1922, Ann. Soc. Ent. Belg. 59:125.
Trichomyiinae Seguy, 1925, Faune de France 12:84.

The subfamily is represented by only the one genus, *Trichomyia*, in North America and Hawaii; the group is readily separated by the characters given in the key above and as discussed under the genus below.

Genus **TRICHOMYIA** Curtis

Trichymyia Curtis, 1839, Brit. Ent. 16(186):745.

This is the only member of the subfamily Trichomyiinae occurring in Hawaii. The group is differentiated from other psychodids by having just four veins in the radius of the wing, with but one longitudinal vein between the bifurcations of radius and medius (fig. 14c). Most writers have considered the single vein between the forked veins to be R_{4+5}, with the forked radial veins consisting of R_2 and R_3. Fairchild (1955:183, 185, and fig. 12) says:

> The statement that the Trichomyiinae have the veins R_4 and R_5 fused into a single vein, recently repeated by Vargas and Diaz Najera (1953), does not appear to be correct. In no psychodid is there any evidence for this in the form of partial fusion from either the distal or proximal ends. The forking of R_4 and R_5 is always in the basal half of the wing. On the other hand there is considerable evidence that R_2 and R_3 have fused to form a single vein in the Trichomyiinae, that this fusion has taken place from the base outwards, and that it has been accompanied by a distal migration of the R_{2+3}–R_4 fork. The tendency to a shortening of R_2 and R_3 is marked in many species of *Phlebotomus*, especially in the subgenus *Sergentomyia*, in *Eophlebotomus* and in *Phlebotomiella* . . . In *Trichomyia* and in *Sycorax*, where R_2 and R_3 have fused, it is quite common to find the tip of R_{2+3} forked or with a short stub a clear indication of the original dual condition of this vein.

The round eyes and the lack of a median eye bridge are also very distinctive. The known Hawaiian species have the eyes very widely separated at the level of the antennae, by a width of at least 11 eye facets. The palpi are three-segmented and have a small sensory pit on inner margin of first segment.

According to Keilin (1914) the larvae of *Trichomyia* live in decaying wood. The early stages of our species have not been studied. There is nothing known about their habits.

Type of genus: *Trichomyia urbica* Curtis.

Key to Species of Trichomyia (from Quate 1954:337)

1. Aedeagus of male enlarged distally, not strongly curved (fig. 14b). Spermathecal ducts of female longer than basal mid-piece of subgenital plate (fig. 14d). R_{2+3} broken a short distance before base (fig. 14c). . . . **hawaiiensis** Quate.

   Aedeagus of male slender distally, strongly curved. Spermathecal ducts of females shorter than basal mid-piece of subgenital plate (fig. 14f). R_{2+3} may be weakened at base but not broken before the base. . . . . **oahuensis** Quate.

Trichomyia hawaiiensis Quate (figs. 14a–d).

Trichomyia hawaiiensis Quate 1954, Proc. Haw. Ent. Soc. 15:337, figures 9a–d.

Endemic. Hawaii (type locality: upper Olaa Forest) and Maui.

Type in the U.S. National Museum.

This species is distinguished by the broad uncurved apex of the male aedeagus (fig. 14b) and by the elongate ducts on the female spermathecae (fig. 14d). The wings differ from the other known Hawaiian species by having vein R_{2+3} broken a short distance near its base (fig. 14c).

Length of wing, 1.5–2.0 mm.; width of wing, 0.6–0.7 mm.

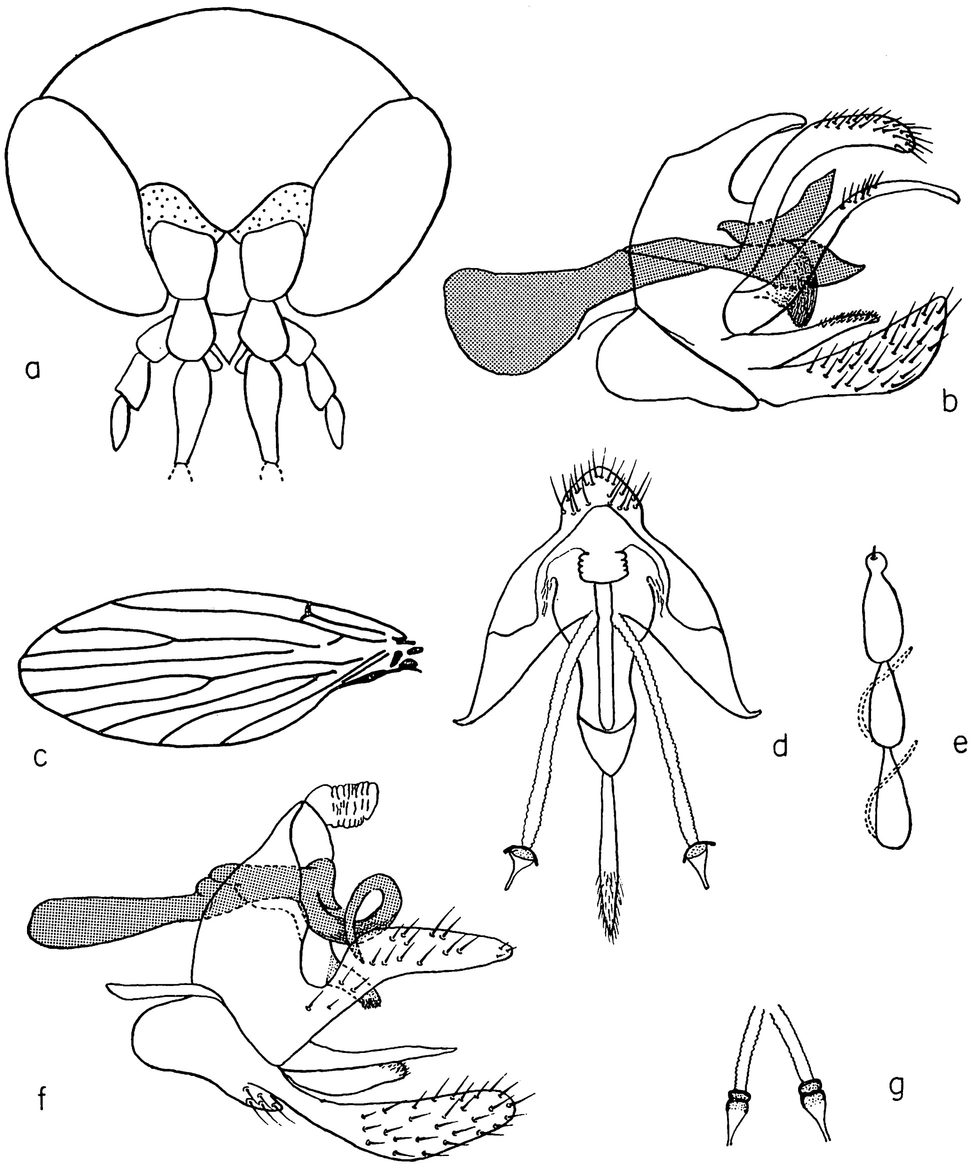

Figure 14—*Trichomyia hawaiiensis* Quate: **a,** head; **b,** male genitalia, lateral view; **c,** wing; **d,** female genitalia, dorsal view. *T. oahuensis* Quate: **e,** apex of antenna; **f,** male genitalia, lateral view; **g,** spermathecae. (Copied from Quate, 1954.)

Trichomyia oahuensis Quate (figs. 14e–g).

Trichomyia sp. Williams, 1943, Proc. Haw. Ent. Soc. 11:325. Hardy, 1952, Proc. Haw. Ent. Soc. 14:445.

Trichomyia oahuensis Quate, 1954, Proc. Haw. Ent. Soc. 15:337–338, figures 6–8.

Endemic. Oahu (type locality: Mt. Olympus).

Type in U. S. National Museum.

Distinguished from *T. hawaiiensis* by genital and wing characters. The apex of the aedeagus is slender and strongly curved (fig. 14f). The ducts of the spermathecae are moderately short (fig. 14g) and the base of vein R_{2+3} is not interrupted.

Length of wing, 1.3 mm.; width of wing, 0.5 mm.

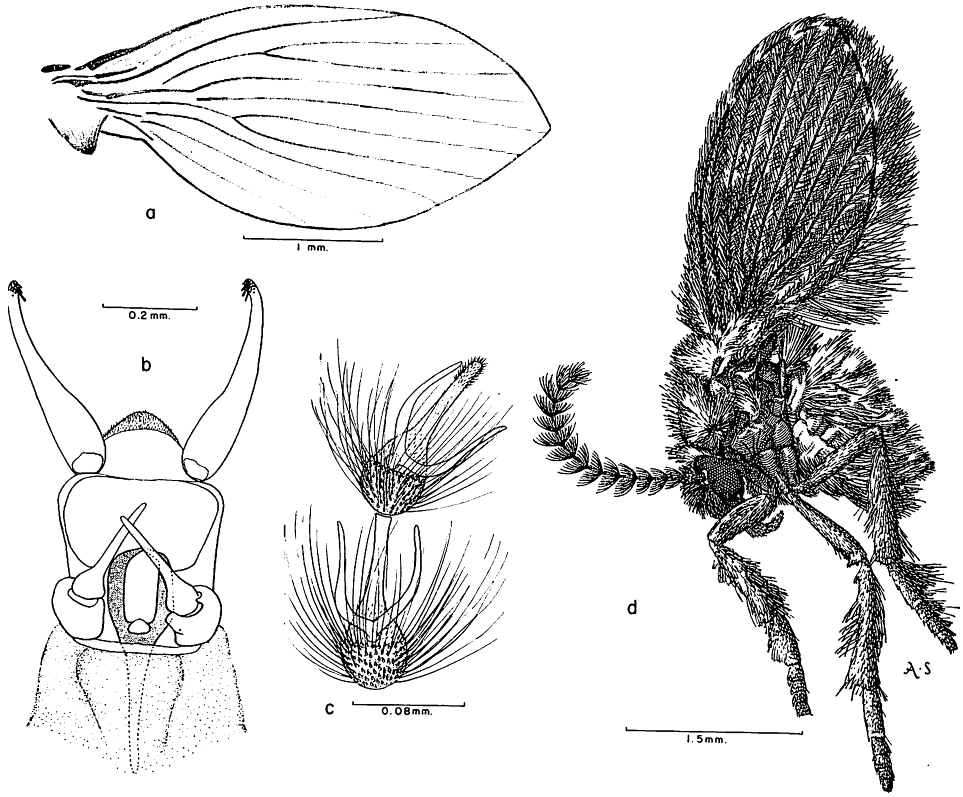

Figure 15—*Telmatoscopus albipunctatus* (Williston): **a,** wing; **b,** male genitalia, ventral view; **c,** apex of antenna; **d,** lateral view of adult.

Subfamily Psychodinae Rondani

Psicodinae Rondani, 1841, Nuovi Annali Sci. Nat. Bologna 6:284.

Psycodina Rondani, 1856, Dipt. Ital., Parma, 1:38.

Psychodinae Eaton, 1895, Ent. Mo. Mag., Ser. 2, 6:210.

Characterized by presence of the eye bridge on the upper part of the front, by four-segmented palpi, five radial veins, two longitudinal veins between the

bifurcations of radius and medius, and by the barrel-shaped or nodose flagellar segments of the antennae.

Genus **TELMATOSCOPUS** Eaton

Telmatoscopus Eaton, 1904, Ent. Mo. Mag., Ser. 2, 15:58.

Medium to large species characterized by having the apical segments of antennae approximately equal in size to the preceding flagellar segments and with an extension, or apiculis, present (fig. 15c). The single Hawaiian species is readily recognized by its large size, predominantly dark vestiture and conspicuous white patches on the wings.

Type of genus: *Pericoma morula* Eaton.

Telmatoscopus albipunctatus (Williston) (figs. 15a–d).

Psychoda albipunctata (Williston), 1893, Ent. News 4:113.

Telmatoscopus albipunctatus (Williston), Tonnoir, 1921, Bul. Mus. Nat. Hist., Paris 27:297.

For synonymy refer to Quate (1955:185).

Common in the lowlands on all the main Islands.

Immigrant. Widely distributed throughout much of the world. First reported in Hawaii in 1930 by Illingworth (1931a:378).

This species is easily recognized by its large size; it is nearly two times larger than any other known Hawaiian species. The color pattern of the vestiture is also distinctive as is the racket-shaped aedeagus and numerous tenaculae on the surstyli (fig. 15b); also the apical flagellar segments of the antennae are very distinctive (fig. 15c).

Length of wing, 2.6–4.1 mm.; width of wing, 1.2–2.0 mm.

Williams (1943:326) gives an excellent account of its biology. It breeds in a wide variety of habitats: sinks, drains, wet mud, tree holes, rain barrels, stagnant pools and rinds of kukui tree fruit. It has also been reared from protozoa cultures in the laboratory. The larvae are scavengers and feed upon decaying organic matter in the water. Williams observed that they may be predaceous under crowded conditions.

Genus **PSYCHODA** Latreille

Psychoda Latreille, 1796, Precis. Caract. Gen. Ins., 152.

Tinearia Schellenberg, 1803, Genres Mouches Dipt., pl. 40.

Trichoptera Meigen, 1803, Illiger's Mag. 2:261.

The bulk of the Hawaiian species belong to this genus. It is related to *Telmatoscopus*, but the species are distinguished by the characters of the antennae (fig. 17j) and by the genitalia of both sexes (figs. 17a and 17b) as mentioned in the generic key above.

Type of genus: *Tipula phalaenoides* Linnaeus.

Key to Known Species of PSYCHODA (Copied From Quate, 1954:341–342)

1. Bases of veins R_3 and M_2 present or only lacking at bifurcation; hairs originating only on wing veins, not on membrane; labellum flattened, bearing row of blunt teeth on apical margin 2

Basal third of veins R_3 and M_2 lacking (fig. 17h); hairs originating on membrane as well as on veins; labellum bulbous, without blunt teeth . . . . **insulicola** Quate.

2(1). Tips of longitudinal veins with brown spots (may be faint in teneral specimens); flagellar segments XIII and XIV broadly fused together 3

Tips of longitudinal veins without markings; terminal flagellar segments clearly separated 4

3(2). Apical portion of female subgenital plate V-shaped; lower process of male aedeagus as large as apical half of main shaft, extending to or beyond apex of main shaft (fig. 16b) . . . . **alternata** Say.

Apical portion of female subgenital plate cigar-shaped, not bilobed; lower process of male aedeagus smaller than apical half of main shaft, not extending to apex of shaft (fig. 18b) . . . . **pseudalternata** Williams.

4(2). Antenna with 14 or 16 segments; bases of R_3 and M_2 present 5

Antenna with 15 segments; bases of R_3 and M_2 lacking . . . . **wirthi** Quate.

5(4). Antenna with 14 segments 6

Antenna with 16 segments 8

6(5). R_{2+3} subequal to length of R_2; female subgenital plate with sides of apical half convergent 7

R_{2+3} noticeably longer than R_2 (6:5); female subgenital plate with sides of apical half parallel . . . . **inornata** Grimshaw.

7(6). Male with wing broad, 2 times as long as broad; female subgenital plate terminating as pair of small, slender lobes . . . . **hardyi** Quate.

Male wing moderately slender, 2½ times as long as broad; female subgenital plate terminating as pair of broadly rounded lobes . . . . **rarotongensis** Satchell.

8(5). Male with surstyle short and stocky, little longer than ninth tergite; female with apical portion of subgenital plate with convergent sides, sides not suddenly narrowing 9

Male with surstyle long and slender, nearly twice as long as ninth tergite; female with apical portion of subgenital plate with parallel or divergent sides, suddenly narrowing near base or center 10

9(8). Teeth of labellum very short, not as long as wide; male with R_{2+3} considerably shorter than R_2 (5:8); female subgenital plate nearly as long as wide. . **salicornia** Quate.

Teeth of labellum normal, considerably longer than wide; male with R_{2+3} subequal to length of R_2; female subgenital plate twice as wide as long. . **williamsi** Quate.

10(8). Male aedeagus with basal portion anterior to base of style (coxite) lightly sclerotized, apical recurved hook moderately long and very slender; female subgenital plate with large, lateral expansions at base extending forward almost to apex of plate . . . . **harrisi** Satchell.

Male aedeagus with basal portion normally sclerotized, apical hook short and broad; female subgenital plate without large lateral expansions at base . **uncinula** Quate.

Psychoda alternata Say (figs. 16a–c).

Psychoda alternata Say, 1824, Narrative Exped. source St. Peter's Riv. 2:358.

For complete synonymy see Tonnoir (1934) and Del Rosario (1936).

Probably present in the lowlands on all the Islands; our records are from Oahu, Maui, Kauai, and Hawaii. Common at lights.

Immigrant; common throughout the world. It was first recorded in Hawaii in 1892 by Grimshaw (1901:6).

The type has been lost.

Many of the records of *P. alternata* throughout the world are apparently erroneous, since it has previously been recognized largely by its wing markings and it has been pointed out by different authors that a complex of species have the brown spots at the tips of the longitudinal veins. These are distinguished by genital and mouthparts characters. Refer to Berdén (1952), Quate (1955:216), and others. Two species of the *alternata* complex occur in Hawaii: *P. alternata* Say and *P. pseudalternata* Williams. These are differentiated by the rod-like structure of the terminal part of the female subgenital plate of *pseudalternata* (fig. 18a) and the V-shaped subgenital plate of *alternata* (fig. 16a). The males are more difficult to separate; the best characters seem to be found in the aedeagus. In *alternata* the lower shaft of the aedeagus is nearly equal in diameter to the main shaft, is rounded apically, and terminates on the same level as the main shaft (fig. 16b). In *pseudalternata* the lower process of the aedeagus is much smaller in diameter than the upper shaft, is sharply pointed, and terminates one-third the length of the main shaft from its apex (fig. 18b). The *alternata* complex of species is characterized by having the tips of the longitudinal veins with brown spots and flagellar segments 13 and 14 fused together (fig. 16c).

Length of wing, 1.4–3.0 mm.; width of wing, 0.7–1.3 mm.

Psychoda hardyi Quate (figs. 16d–g).

Psychoda sp.2 Williams, 1943, Proc. Haw. Ent. Soc. 11:337.

Psychoda hardyi Quate, 1954, Proc. Haw. Ent. Soc. 15:348, figures 25–27.

Endemic. Oahu, Kauai, Hawaii, and Maui. (Type locality: Honolulu.) Probably common on all the main Islands.

Type in the U. S. National Museum.

This is a common species at light. It breeds in large numbers over the lowlands in all sorts of decaying plant materials such as rotting leaves, fruits, etc. It is easily recognized by the three anterior branches of the sensory filaments of each flagellar segment (fig. 16d), by the broad wings of the male, and by the different female subgenital plate, in combination with the 14-segmented antennae. The

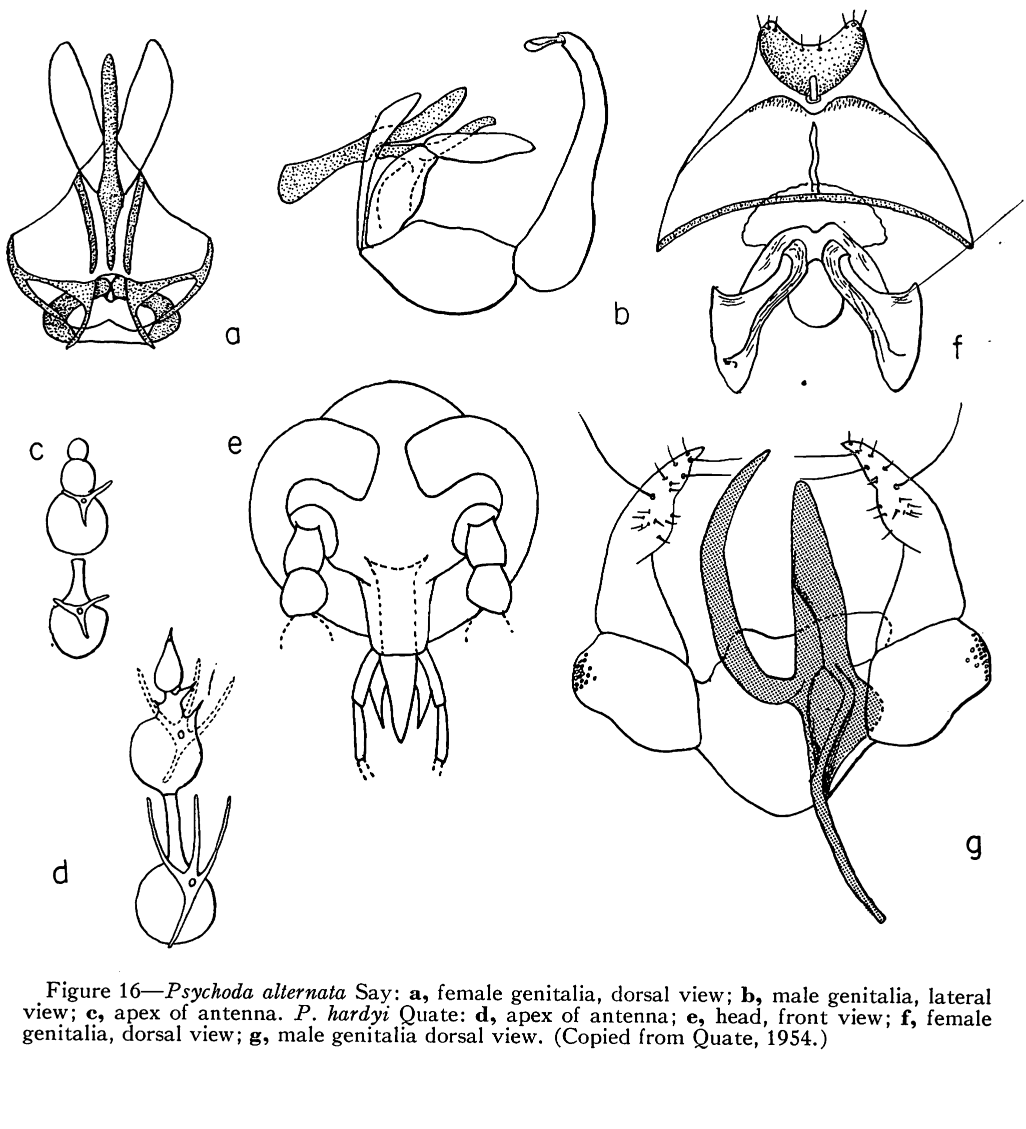

Figure 16—*Psychoda alternata* Say: **a,** female genitalia, dorsal view; **b,** male genitalia, lateral view; **c,** apex of antenna. *P. hardyi* Quate: **d,** apex of antenna; **e,** head, front view; **f,** female genitalia, dorsal view; **g,** male genitalia dorsal view. (Copied from Quate, 1954.)

subgenital plate is markedly tapered from base to apex and terminates in a pair of small lobes separated by a concavity (fig. 16f). The vestiture is chiefly dark gray on the body and dark brown on the antennae and legs.

Length of wing, 1.5–2.0 mm.; width of wing, 0.8–0.9 mm.

Psychoda harrisi Satchell (figs. 17a–c).

Psychoda harrisi Satchell, 1950, Trans. Roy. Ent. Soc. Lond. 101:171.

Oahu, Hawaii, and Maui. Probably on all the main Islands.

Immigrant. Originally described from New Zealand but, according to Satchell, occurs widely throughout Australia and Tasmania.

Type in the Cawthron Institute, Nelson, New Zealand.

A gray-haired species characterized by the distinctive genitalia of both sexes. The female subgenital plate is "fleur-de-lis" shaped, has a pair of large basal lobes, and the apical portion is slender basally and widened distally (fig. 17a). The male aedeagus has a characteristic beak-like apex and the diststyli are elongate and incurved (fig. 17b). The antenna possesses 16 segments.

Length of wing, 1.5–1.9 mm.; width of wing, 0.7–0.9 mm.

Dr. Satchell examined specimens of *P. harrisi* from Hawaii and stated that they were almost identical to specimens from New Zealand. He found only slight variations in the aedeagus of the male.

Psychoda inornata Grimshaw (figs. 17d–g).

Psychoda inornata Grimshaw, 1901, Fauna Hawaiiensis 3:6.

Oahu, Maui, Hawaii, and probably the other main Islands (Type locality: Kona, Hawaii); first recorded in 1892.

Immigrant. North America, Canada, and Alaska.

Type in the British Museum (Natural History).

Quate (1954:347) placed *P. severini* Tonnoir (1922:78) as a synonym of *inornata.* Paul Freeman, of the British Museum, had examined the type and on the basis of his examination of the wing and antenna said they were possible synonyms. Dr. Quate says, "Dr. Geoffrey Satchell later confirmed this synonymy by a critical examination of the type after it had been boiled and cleaned." The species in Hawaii is known only from females and later Quate (1955:216) said, "this synonymy is now open to question and cannot be settled until males of the Hawaiian form are available." Dr. Satchell has since studied more specimens from North America and has found that even though the females are identical to those of *P. severini* the males are quite distinct. He stated, in correspondence, "It is thus clear that we had been rash in synonymising *inornata* Grimshaw with *severini* Tonnoir merely on the basis of the similarity of the females."

Since our species is known only from the females it is possible that it reproduces parthenogenetically; if so, it probably would not be separable from the cosmopolitan *P. severini parthenogenetica* Tonnoir. Males will have to be found before the status of *inornata* can be clarified.

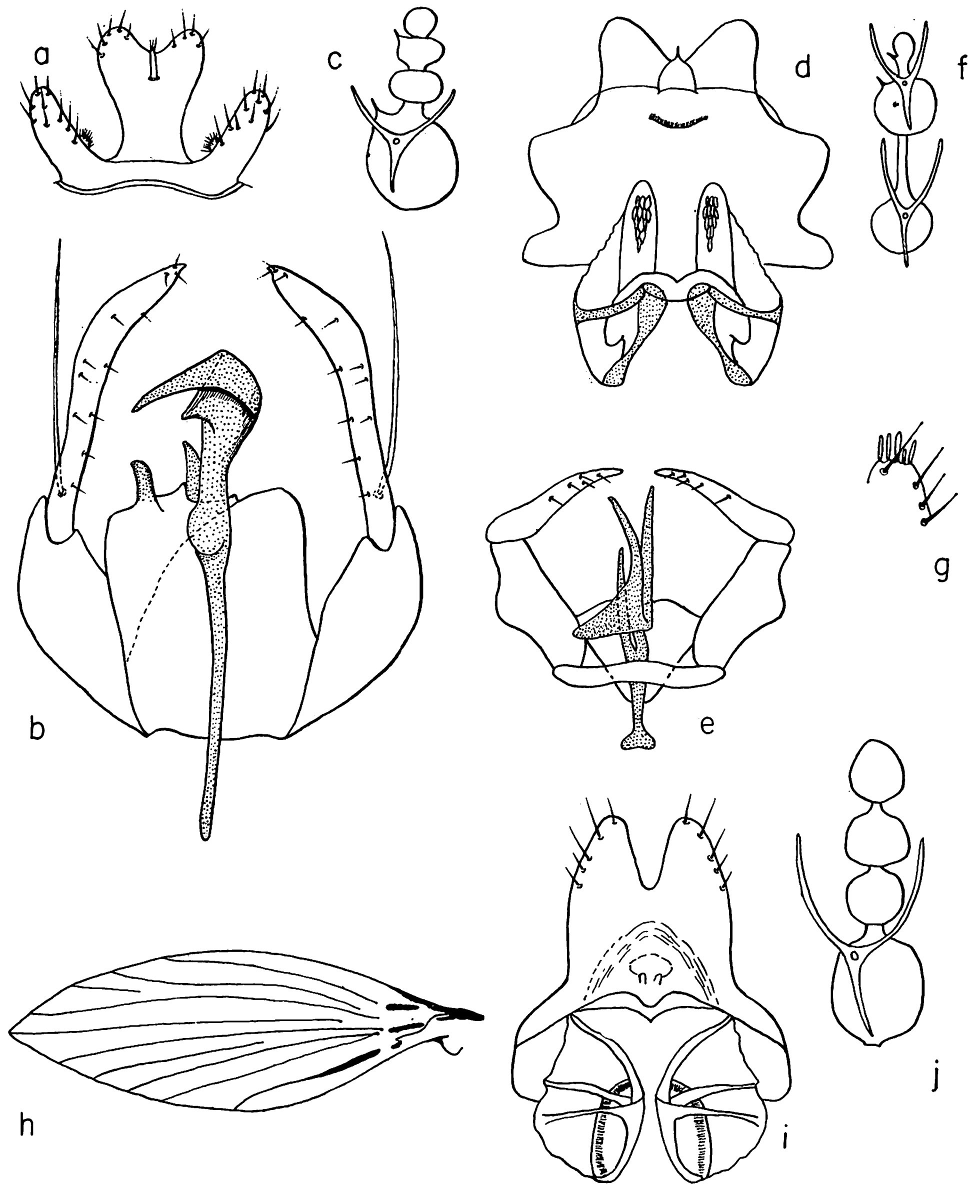

Figure 17—*Psychoda harrisi* Satchell: **a,** female genitalia, dorsal view; **b,** male genitalia, dorsal view; **c,** apex of antenna. *P. inornata* Grimshaw: **d,** female genitalia dorsal view; **e,** male genitalia, dorsal view; **f,** apex of antenna; **g,** labellum of female. *P. insulicola* Quate: **h,** wing; **i,** female genitalia, dorsal view; **j,** apex of antenna. (Copied from Quate, 1954.)

Quate (1954:347) said the behavior of *P. inornata* in the Hawaiian Islands appears to differ from its actions in North America. He found this species very commonly represented in light-trap collections made throughout the United States (17 states), but for some reason or another it apparently is not strongly

attracted to lights in Hawaii. He found but six specimens of *inornata* out of approximately 1,000 light-trap collected specimens which he studied. It is possible that the North American species is distinct from that in Hawaii.

P. inornata is a dull golden species characterized by having a 14-segmented antenna, by having vein R_{2+3} noticeably longer than R_2, and by the female subgenital plate with sides parallel on the apical half (fig. 17a). The male genitalia are as in figure 17b (these are taken from Quate, drawn from North American specimens). The males have not been taken in Hawaii and Quate's figures may actually pertain to a new species.

Length of wing, 1.4–2.8 mm.; width of wing, 0.5–1.0 mm.

Psychoda insulicola Quate (figs. 17h–j).

Psychoda insulicola Quate, 1954, Proc. Haw. Ent. Soc. 15:342, figures 1–3.

Oahu (Type locality: Honolulu).

Type in the U. S. National Museum.

Immigrant. Previously thought to be an endemic species but it has been recently reported by Quate (1955:225) from Georgia and Alabama.

This species is easily separated from other *Psychoda* by the hairy wing membrane, by the absence of the bases of R_3 and M_2, by the bulbous unarmed labellum (fig. 17g), and by the deeply cleft subgenital plate of the female (fig. 17i). Tonnoir (1922:59) proposed the subgenus *Trichopsychoda* to include the species of the genus *Psychoda* with hairy wing membrane. He later (1940:61) raised this to generic status and the group has been treated as a genus by Satchell (1953:391). Quate (1954:343; 1955:225–226) prefers to treat *insulicola* under *Psychoda* rather than under *Trichopsychoda*. He says, "At the present time the true relationship of those species with the hairy membrane is not known and a conservative viewpoint is maintained until a more thorough classification of the family is completed."

Length of wing, 1.9–2.2 mm.; width of wing, 0.6–0.8 mm.

Male unknown.

Psychoda pseudalternata Williams (figs. 18a–c).

Psychoda pseudalternata Bryan, 1940, Proc. Haw. Ent. Soc. 10:370 (*nomen nudum*).

"*Psychoda pseudalternata* Tonnoir (unpublished)" Williams, 1943, Proc. Haw. Ent. Soc. 11:336 (*nomen nudum*).

Psychoda pseudalternata Williams, 1946, Proc. Haw. Ent. Soc. 12:637.

Oahu. Probably widespread throughout the Islands.

Immigrant. Australia (Type locality: Canberra) and New Zealand.

Lectotype in the B. P. Bishop Museum.

This is one of the most abundant species of Psychodidae on Oahu. It has been very common in all light-trap collections that have been examined. It is closely allied to *alternata* and can be differentiated only by genital characters. The females are recognized by the rod-like structure of the terminal part of the subgenital

plate (fig. 18a) and the males by the structure of the aedeagus; in *P. pseudalternata* the lower process of the aedeagus is much smaller in diameter than the upper shaft, is sharply pointed, and terminates one-third the length of the main shaft from its apex (fig. 18b). For more complete descriptions refer to Quate (1954:345) and to Satchell (1953: 373–374). Satchell says that the female genitalia are "unique in that the subgenital plate is apparently missing, its place being taken by a large cylindrical tubular process into which opens two pairs of sclerotized capsules probably of a glandular nature; this structure is normally partly hidden under a curtain of dense, long squamuliferous hairs borne on the posterior margin of the last sternum."

Length of wing, 1.6–1.7 mm.; width of wing, 0.7–0.8 mm.

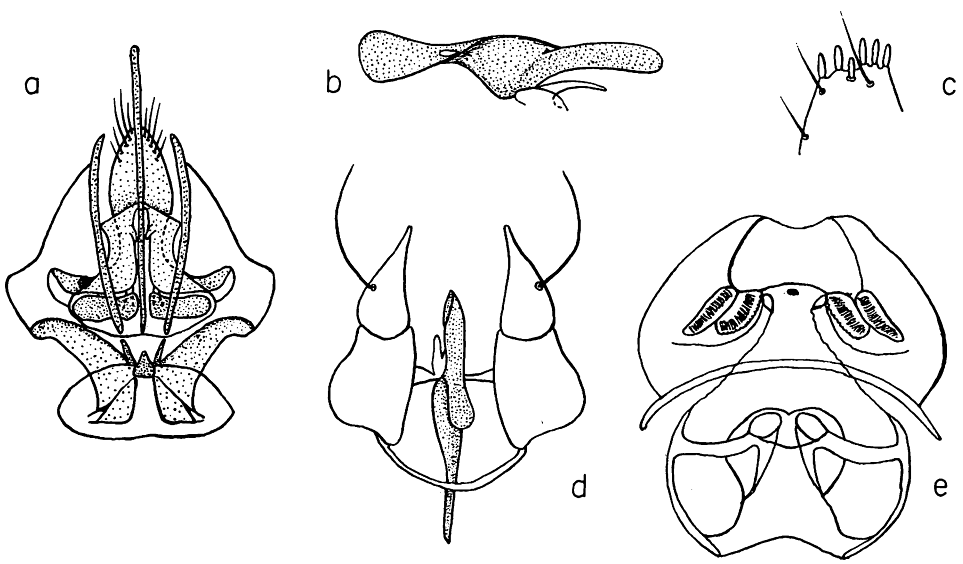

Figure 18—*Psychoda pseudalternata* Williams: **a,** female genitalia, dorsal view; **b,** aedeagus of male genitalia, lateral view; **c,** labellum. *P. rarotongensis* Satchell: **d,** male genitalia, dorsal view; **e,** female genitalia, dorsal view. (Copied from Quate, 1954.)

Psychoda rarotongensis Satchell (figs. 18d–e).

Psychoda rarotongensis Satchell, 1953, Proc. Roy. Ent. Soc. Lond. Ser. B., Tax. 22:183.

Psychoda lucia Quate, 1954, Proc. Haw. Ent. Soc. 15:349, figures 28–31. Synonymy by Quate (1955:208).

Oahu, Kauai, and Hawaii. Probably on all the main Islands.

Immigrant. Very widespread. It has been recorded from the Society Islands, Cook Islands (type locality: Rarotonga), the southern United States, West Indies, Transvaal, and Algeria.

Type in the British Museum (Natural History).

This species fits near *P. hardyi* and *inornata* by having just 14 segments in the antenna. It is also like *hardyi* in having the sensory filaments composed of one posterior and three anterior branches. It is distinguished from all known Hawaiian species by the broad bilobed subgenital plate of the female (fig. 18e) and by the male genital structures as shown in figure 18d; the dististyli are enlarged basally and each bears a very long hair about one-third the distance from the base.

Length of wing, 1.2–1.4 mm.; width of wing, 0.4–0.5 mm.

Psychoda salicornia Quate (figs. 19a–e).

Psychoda salicornia Quate, 1954, Proc. Haw. Ent. Soc. 15:350, figs. 32–36.

Oahu.

Immigrant. California (Type locality: Alviso, Santa Clara County, California).

In California it breeds in the salt marshes along the coast in association with the pickleweed (*Salicornia ambigua*). The Hawaiian records are based only on light-trap collections; it is not known whether it exists under the same ecological conditions here as it does on the Mainland.

Type in the California Academy of Sciences, San Francisco.

This is a brown-haired species resembling *P. williamsi* in having 16 segments in the antenna with the 3 terminal segments separated (fig. 19a) and also in the general details of the male genitalia. It is differentiated by the very short teeth on the labellum (fig. 19b), the costal brush of hairs and scales on the lower surface of the male wing and by the genital characters of both sexes as shown in figures 19c and 19e. In the female the subgenital plate is broad and distinctly concave on the hind margin. The male surstyli are short, enlarged basally, and slightly longer than the ninth tergum; the aedeagus is enlarged basally, rather fan-shaped and flattened laterally, and terminating in a stout downward curved hook flanked by a slender acute upward curved hook (fig. 19d).

Length of wing, 2.1–2.3 mm.; width of wing, 0.8–1.1 mm.

Psychoda uncinula Quate (figs. 19f–i).

Psychoda phalaenoides Wirth, 1947, Proc. Haw. Ent. Soc. 13:7, *nec* Linnaeus, 1758, Syst. Nat. Ed. 10(32):588.

Psychoda uncinula Quate, 1954, Proc. Haw. Ent. Soc. 15:355, figures 40–43.

Endemic. Oahu, Maui, and Hawaii. (Type locality: Honolulu.)

Type in the U. S. National Museum.

This species was erroneously identified as *P. phalaenoides* Linnaeus by W. F. Rapp, Jr., and incorrectly reported from the Hawaiian Islands by Dr. W. W. Wirth. Specimens upon which the record was based, collected on Mt. Tantalus by Wirth, were obtained from Mr. Rapp and were found by Dr. Quate to be distinct from *phalaenoides*.

This is a chiefly gray species characterized from other Hawaiian psychodids with 16-segmented antennae by the parallel-sided subgenital plate of the female (fig. 19f) and by the barbed aedeagus of the male (fig. 19g). *P. uncinula* is most

closely related to *harrisi* Satchell. The female genitalia are quite differently formed, however, as shown in figures 17a and 19f. The male genitalia are similar but *uncinula* has the barb at the tip of the aedeagus dorsal in position and sharply

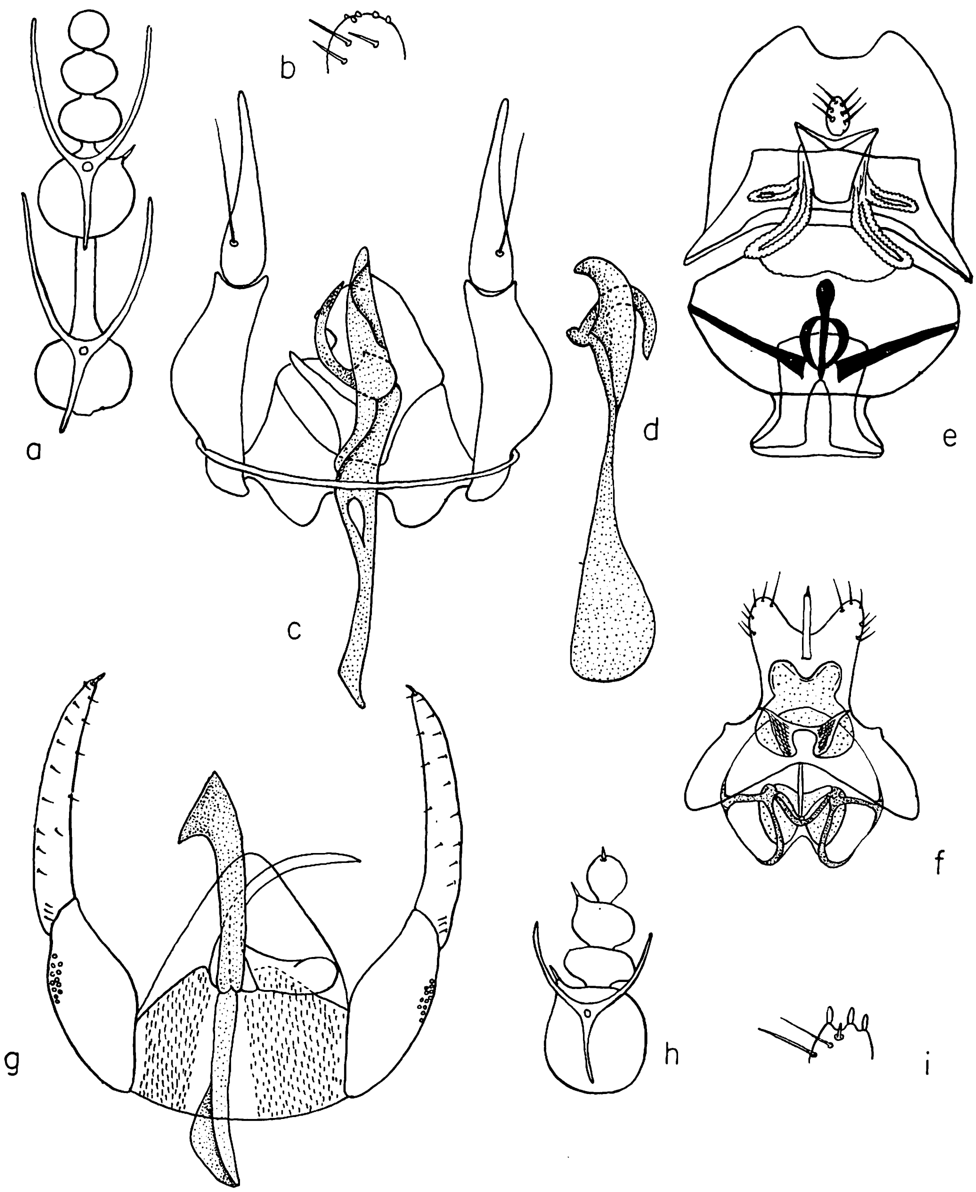

Figure 19—*Psychoda salicornia* Quate: **a,** apex of antenna; **b,** labellum of female; **c,** male genitalia, dorsal view; **d,** aedeagus, lateral view; **e,** female genitalia, dorsal view. *P. uncinula* Quate: **f,** female genitalia, dorsal view; **g,** male genitalia, dorsal view; **h,** apex of antenna; **i,** labellum of female. (Copied from Quate, 1954.)

tapered to an acute apex (fig. 19g), while the recurved hook of the aedeagus of *harrisi* is ventral in position, slender, and attenuated (fig. 17b). As pointed out by Quate (1954) the genital structures of *P. uncinula* differ markedly from those of *phalaenoides*. Also, the former has 16-segmented antennae while those of the latter have but 15 segments.

Length of wing, 1.6–2.1 mm.; width of wing, 0.7–0.9 mm.

Psychoda williamsi Quate (figs. 20a–c).

Psychoda sp.1 Williams, 1943, Proc. Haw. Ent. Soc. 11:336.

Psychoda cinerea Hardy, 1952, Proc. Haw. Ent. Soc. 14:445, *nec* Banks, 1894, Canadian Ent. 26:331.

Psychoda williamsi Quate, 1954, Proc. Haw. Ent. Soc. 15:352, figures 44–45.

Endemic. Oahu, Hawaii, and Maui. (Type locality: Palikea, Oahu.) Found principally in the highlands breeding in rotting vegetation.

Type in U. S. National Museum.

This species was previously identified (by Quate) as *P. cinerea* Banks. The two are closely related but are separated by genital characters as pointed out by Quate (1954). *P. williamsi* is similar to *salicornia* in having the vestiture brown and the antennae 16-segmented with the three terminal segments separated (fig. 20a). It is distinguished from all known Hawaiian species by the broad, short subgenital plate of the female with a pair of small mound-like apical lobes separated by a truncate margin (fig. 20b) and by the structure of the male genitalia as shown in figure 20c.

Length of wing, 1.6–2.1 mm.; width of wing, 0.8 mm.

Psychoda wirthi Quate (figs. 20d–g).

Psychoda wirthi Quate, 1954, Proc. Haw. Ent. Soc. 15:346, figures 21–24.

Endemic. Oahu, Maui, and Hawaii. (Type locality: Honolulu.)

Type in the U. S. National Museum.

This species is distinguished from other Hawaiian psychodids by the divergent-sided female subgenital plate. The genital digit originates at the base rather than near the middle of the plate (fig. 20d) and bases of veins R_3 and M_2 are absent. It is like *P. alternata* and *pseudalternata* by having just 15 segments in the antennae; the wings, however, lack the brown spots at the tips of the veins and the genitalia are very different. The male aedeagus is rod-like and the surstyli are long and slender, two times longer than the ninth tergum (fig. 20e).

Length of wing, 1.3–1.8 mm.; width of wing, 0.6–0.7 mm.

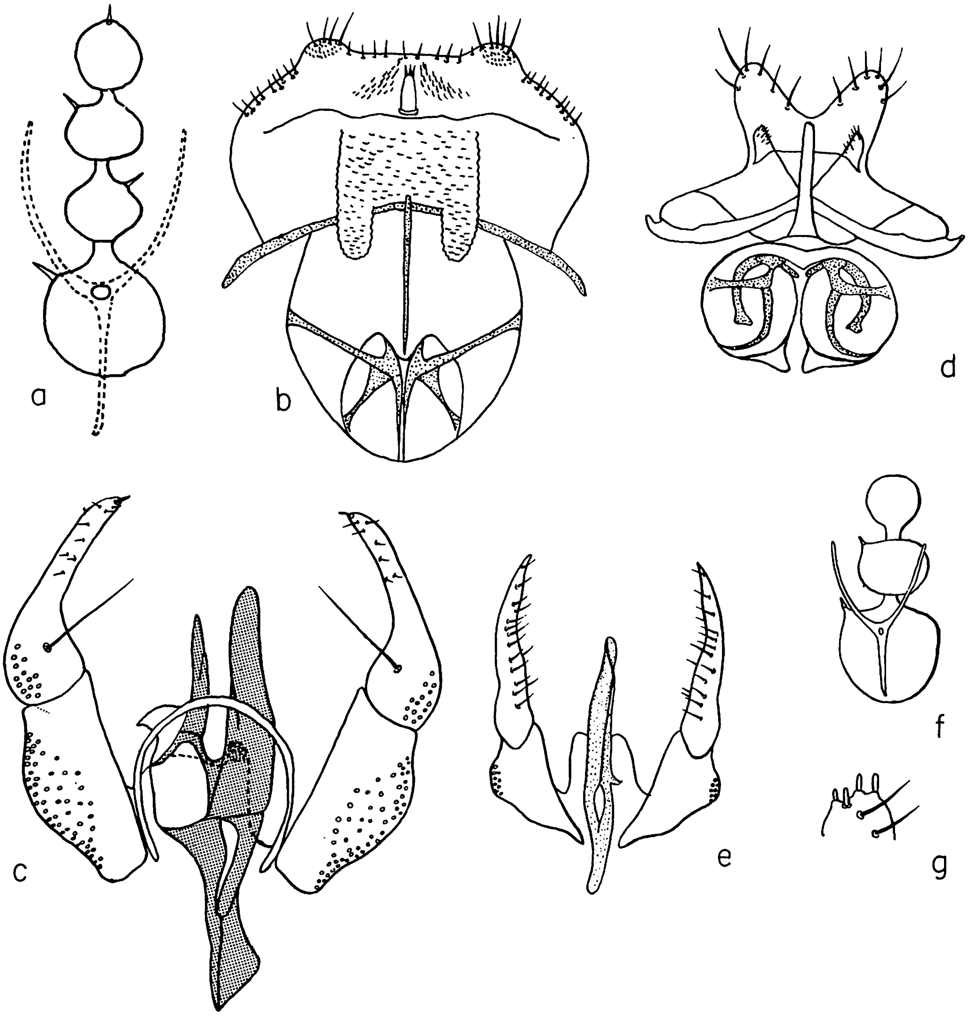

Figure 20—*Psychoda williamsi* Quate: **a,** apex of antenna; **b,** female genitalia, dorsal view; **c,** male genitalia, dorsal view. *P. wirthi* Quate: **d,** female genitalia, dorsal view; **e,** male genitalia, dorsal view; **f,** apex of antenna; **g,** labellum. (Copied from Quate, 1954.)

Family CULICIDAE Billberg
Mosquitoes

Culicides Billberg, 1820, Enum. Ins. Mus. Billberg, Stockholm, Gadel 4:122. Latreille, 1825, Familles naturelles du regne animal, Paris, p. 482.
Culicidae Stephens, 1829, Syst. Cat. Brit. Ins., p. 51.
Culicites Newman, 1834, Ent. Mag. 2:388.

The name of the type genus, *Culex*, is from the Latin, meaning a gnat or midget From a public health standpoint, mosquitoes are perhaps the most important

insects in the entire world. In other areas, especially throughout much of the tropics of the world, they are very important pests and cause great economic losses by transmitting a number of diseases of man and animals and by causing extreme annoyance by their bites. In Hawaii the day-biting mosquitoes have transmitted dengue fever in several epidemics in the past (see Introduction). *Culex quinquefasciatus* Say and *Aedes albopictus* (Skuse) are both transmitters of *Dirofilaria immitis* in dogs and the former species, at least, is a vector of fowl pox and bird malaria. Mosquitoes, especially the night biters, are very annoying to man as well as to domestic animals, particularly young poultry, dogs, cattle, and horses.

Mosquitoes are controlled by getting rid of their breeding sites and where this is not feasible by treating the habitats with insecticides. The control of day-biting domestic, mosquitoes is largely a matter of public education and of teaching the home owner not to leave water in flower vases over a long period of time and not to allow tin cans or trash, in which mosquitoes might breed, lying about the yard. Under the regulations adopted by the State on August 3, 1906, mosquito prevention and abatement was made a part of the rules and regulations of the State Board of Health. A mosquito-control department was set up and a staff of inspectors employed under the direction of at least one medical entomologist. As far as funds have been available they have done an effective job of keeping disease-bearing mosquitoes under control and there are now relatively few areas where pest mosquitoes are a serious problem.

An immense amount of work has been done on this family and the literature on the group is voluminous. Since we have such a limited fauna of well-known introduced species in Hawaii, there is no need of treating these in detail, and references are given to more comprehensive studies where further information is desired. (See Carpenter and La Casse, 1955; Horsefall, 1955; Matheson, 1944; Edwards, 1932; Dyar, 1928; and La Casse and Yamaguti, 1950.)

The mosquitoes are readily distinguished from other Hawaiian flies by their long sucking beak and by the scaly body and wings.

Just three species of blood-sucking mosquitoes occur in Hawaii—two day biters, *Aedes aegypti* (Linnaeus) and *A. albopictus* (Skuse), and one night biter, *Culex quinquefasciatus* Say. The latter species has evidently been present here since about 1826 (Van Dine, 1904:7; also refer to Introduction for historical account) and the other species apparently were introduced shortly before 1900. Two species of predacious mosquitoes, *Toxorhynchites brevipalpis* Theobald and *T. splendens* (Wiedemann), have been purposely introduced into the State within the last few years in an attempt to control the day-biting mosquito *Aedes albopictus*.

There has been much disagreement in the literature regarding the family and subfamily breakdowns of the mosquitoes. It has been rather common practice to include the chaoborid midges as a subfamily (Chaoborinae) of Culicidae, and some authors have also included the dixid midges as a subfamily (Dixinae) (see Carpenter and La Casse, 1955:25). I have consulted Dr. Alan Stone concerning the position of these groups and he prefers to treat them as three distinct families.

These three families agree in having rather similar wing venation; the scape of the antenna rudimentary and the pedicel enlarged; the pronotum is completely divided and the praescutum and scutum combined. The Dixidae are distinguished from the other two families by lacking scales on the wings and by having 14 segments in the flagellum, rather than 13. The Chaoboridae are distinguished from Culicidae by having the mouthparts short, not prolonged into a sucking beak, and the scales of the wings are almost confined to the fringe. Only the family Culicidae is represented in Hawaii.

The true mosquitoes are characterized by having the mouthparts prolonged into a long sucking beak and the wings with scales on the veins. The flagellum of the antenna is 13-segmented, and the scape is small and hidden beneath the large globular pedicel. The antennae are densely plumose in the males of Hawaiian species. Mosquitoes are entirely covered with scales, and the coloration and patterning of the scales of the body, legs and wings is of importance in recognizing species. The male genitalia are rather complexly developed and exhibit excellent characters for distinguishing species. The entire genitalia undergo a rotation of 180° on the longitudinal axis shortly after the adults emerge so that the structures which are normally dorsal are on the venter and vice versa. For the male genital structures refer to figures 22a, 23a, 24a and 25a and to one of the standard works cited above.

The larvae and pupae are aquatic. The former possess very striking characters for separation of genera and species. The chaetotoxy of the entire body is very diversified and the development of the numerous setae and bristles affords excellent diagnostic characters, as do the size and shape of the siphon, the dorsal plate on the 9th segment, anal gills, and mouthparts. The setae of the head, thorax, and abdominal terga are rather consistent in position and, for convenience sake, are referred to by numbers (fig. 24c). The pupal stages have received comparatively little attention taxonomically, but, in those groups which have been studied, good characters have been found in the shape and development of the paddles and respiratory trumpets and in the chaetotoxy of the abdomen (see Knight and Chamberlain, 1948).

Following Dr. Stone's classification (in correspondence) our mosquitoes fall into two subfamilies: the Culicinae and the Toxorhynchitinae; the subfamily Anophelinae is not represented in our fauna. The Culicinae break down into the tribes Culicini (containing one species) and Aedini (containing two species).

Key to Subfamilies of Culicidae (Adapted from the Tribal Classification of Carpenter and La Casse, 1955)

Adults

1. Very large, chiefly metallic blue or green species. Proboscis rigid, the apical half strongly bent downward (fig. 21b). Scutellum rounded on hind margin. Predaceous mosquitoes . . . . **Toxorhynchitinae.**

Moderate sized, not metallic. Proboscis not rigid and not bent downward. Scutellum trilobed on hind margin. . . . . **Culicinae.**

PUPAE

1. Swimming paddles with the outer part elongated, lobe-like, produced beyond the termination of the midrib and inner part of paddle (fig. 21g) . . . . **Toxorhynchitinae.**
   Paddles not produced on outer portion . . . . **Culicinae.**

LARVAE

1. Mouth brushes prehensile, each composed of 10 stout rods (fig. 21d). 8th abdominal segment without a comb and no pecten on the siphon (fig. 22b) . . . . **Toxorhynchitinae.**
   Mouth brushes not prehensile and each composed of 30 or more hairs. A comb present on the 8th segment and pecten present on the siphon (fig. 25b) . . . . **Culicinae.**

Subfamily TOXORHYNCHITINAE Theobald

Megarhina Theobald, 1901, Mon. Culicidae 1:97.
Megarhininae Neveu-Lemaire, 1902, C. R. Soc. Biol. Paris, 54:1330, and Mem. Soc. Zool. France 15:206.
Toxorhynchitinae Theobald, 1905, Gen. Ins. 26:13.

This subfamily contains but a single genus, *Toxorhynchites* Theobald.

Genus **TOXORHYNCHITES** Theobald

Megarhinus Robineau-Desvoidy, 1827, Mem. Soc. Hist. Nat. 3:403. Preoccupied by *Megarhinus* Rafinesque, 1820, Western Review 3:251.
Toxorhynchites Theobald, 1901, Jour. Trop. Med. 4:234; 1901, Mon. Culicidae 1:244. *Nec Toxorhynchites* Howard, 1901, Mosquitoes, Pub. by McClure, Phillips and Co., N.Y. p. 154. See Stone and Knight (1957).

Very large, predominantly metallic blue, green, or purple with white scales on sides of thorax and abdomen and on legs. The wings have blue scales along the veins in the anterior and basal regions. The strongly down-curved proboscis (fig. 21b) is very characteristic. The palpi of the male are elongate, distinctly longer than the proboscis or the wings. In the females of our species the palpi are approximately half as long as the straight basal section of the proboscis (fig. 21a).

Four species have been introduced into Hawaii to aid in control of day-biting mosquitoes: *T. theobaldi* (Dyar and Knab) (as *T. hypoptes* (Dyar and Knab), was introduced from Panama in 1953 and early 1954; *T. inornatus* (Walker) from New Britain in 1929 (Pemberton, 1931:360); *T. brevipalpis* Theobald from Africa in 1950 (Bonnet and Hu, 1951:237); and *T. splendens* (Wiedemann) from the Philippine Islands in 1954 (Weber, 1955:637). Apparently only *brevipalpis* and *splendens* are definitely established. The *T. hypoptes* colony died out in the laboratory and the species was never released. *T. inornatus* survived in the field about six months and then died out (Bonnet and Hu, 1951:237). No attempt has been made to reestablish this species.

Type of genus: *Toxorhynchites brevipalpis* Theobald.

Key to Toxorhynchites Adults

MALES

1. Lateral tufts of 6th abdominal segment all white; tufts of 8th all yellow to orange. Second tarsal segment of middle and hind legs with a broad white basal band. Mesonotum metallic blue, green, or purple, not gray on the lateral margins .... **brevipalpis** Theobald.

   Lateral tufts on 6th segment mostly black, with white hairs near anterior margin; tufts all black on segments 7 and 8. Second tarsal segment of all legs black. Mesonotum more dull brownish, with the lateral margins grayish .... **splendens** (Wiedemann).

FEMALES

1. Front basitarsus all black (or metallic blue-black to purple). Middle tarsus with a narrow white band at base of 1st segment and a broad white band occupying basal two-thirds to three-fourths of 2nd, otherwise black. Hind basitarsus with just a small patch of white scales on upper surface at base. Mesonotum as in male.............. .... **brevipalpis** Theobald.

   Front basitarsus all white except for a narrow band of black at base. Middle tarsus with a broad white band over basal three-fifths of 1st and with segments 2–4 entirely white. Hind basitarsus yellow-white on basal two-fifths. Mesonotum as in the male .... **splendens** (Wiedemann).

Key to Toxorhynchites Larvae

1. Siphon one-third longer than wide (fig. 22e). Hair 1 of prothorax 6- to 10-branched; hair 2, 2- to 6-branched (fig. 22f). Spines on distal margin of the saddle of the 9th segment as in figure 22e........... **splendens** (Wiedemann).

   Siphon just slightly longer than wide (fig. 22b). Hair 1 of prothorax 3-branched; hair 2, 2-branched (fig. 22c). Spines on distal margin of saddle as in figure 22b.................................... **brevipalpis** Theobald.

Toxorhynchites brevipalpis Theobald (figs. 21a–g, 22a–c).
Toxorhynchites brevipalpis Theobald, 1901, Mon. Culicidae 1:245.

Oahu. Released also on Kauai, Maui, Molokai, and Hawaii (see Weber, 1955:637).

Immigrant. Africa. Introduced in 1950 (Bonnet, 1951:226, and Bonnet and Hu, 1951:237) and apparently established in two or more valleys on Oahu and probably on other islands.

Type locality: Natal, South Africa.

Type in the British Museum (Natural History).

Predominantly metallic blue, green, or purple species. The males are characterized by the all-white lateral tufts on the 6th abdominal segment and the yellow to orange lateral tufts on the 8th segment, also by the broad white band at base of each middle and hind tarsus and by the genital characters as shown in figure 22a. The females have the body coloring and hair tufts of the abdomen the same as in the male. The front basitarsus is entirely dark colored. The middle tarsus has a narrow white band at the base of the 1st segment and a broad white band occupying the basal two-thirds to three-fourths of the 2nd segment. The hind basitarsus has just a small patch of white scales on the upper surface at the base. The palpi are approximately one-half as long as the straight section of the proboscis. Male genitalia are as in figure 22a.

Length: body 8.0–10.0 mm.; wings, 6.7–7.75 mm.

Larvae are as in figures 21d–e and 22b–c. I have not been able to find satisfactory characters for separating the larvae of *brevipalpis* from those of *splendens*. They look very much alike and the chaetotaxy and other details of structure are so much alike that any differences which I have found seem rather trivial and may fit into the range of variation between individuals. *T. brevipalpis* seems to have hair 1 of the prothorax consistently three-branched and hair 2 is two-branched. In the specimens of *splendens* which I have studied, hair 1 has been 6- to 10-branched and hair 2 has been 2- to 6-branched. The siphon is shorter and thicker compared to its length in *brevipalpis*, measuring about 40 marks in width and 45 to 50 in length (fig. 22b). In the specimens of *splendens* which have been examined, the siphon is longer, more slender compared to its length and measuring 40–50 wide by 65–80 in length (fig. 22e). Also the row of spines along

the distal edge of the saddle seems to show differences in the two species: *brevipalpis* specimens seem to have more of the short spines interspersed with the longer spines than do specimens of *splendens* (figs. 22b and e). The comparative differences in the siphons seem to be the best character for separating the larvae of these species.

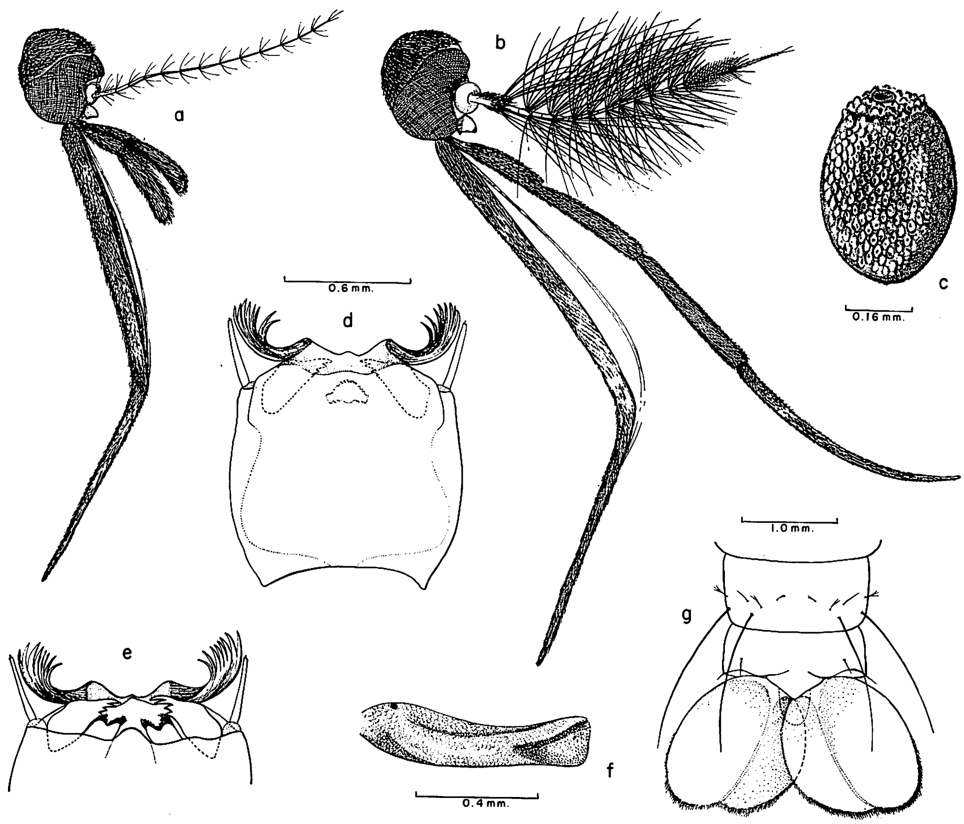

Figure 21—*Toxorhynchites brevipalpis* Theobald: **a,** head of adult female; **b,** head of adult male; **c,** egg; **d,** larval head, dorsal view; **e,** apical portion of larval head, ventral view; **f,** respiratory trumpet of pupa; **g,** pupal paddle.

Toxorhynchites splendens (Wiedemann) (figs. 22d–f).
Culex splendens Wiedemann, 1819, Zool. Mag. 1:2.

For synonymy see Barraud (1934:24).

Released on Oahu, Kauai, Hawaii, Maui, and Molokai, March to September, 1954.

To date, verified recoveries of *splendens* have been made only in Manoa Valley (Waioli Tea Room) and Kalihi-uka, on Oahu, and from Kalaheo and Lihue,

Kauai. The specimens recorded by Weber (1955:638) from Manoa Valley were taken near one of the release points not long after the field releases were made.

Immigrant. Widespread throughout the southwest Pacific, Fiji, Southeast Asia, Thailand, Burma, Ceylon and India.

Type locality: Java.

Type in the Universitetets Zoologiske Museum, Copenhagen, Denmark.

This species differs from *T. brevipalpis* by having the mesonotum more dull brownish in color, grayed on the lateral margins. The lateral tufts of the 6th segment are mixed white or yellow and black in both sexes, usually white in the male and yellow in the female, with the pale hairs confined near the anterior

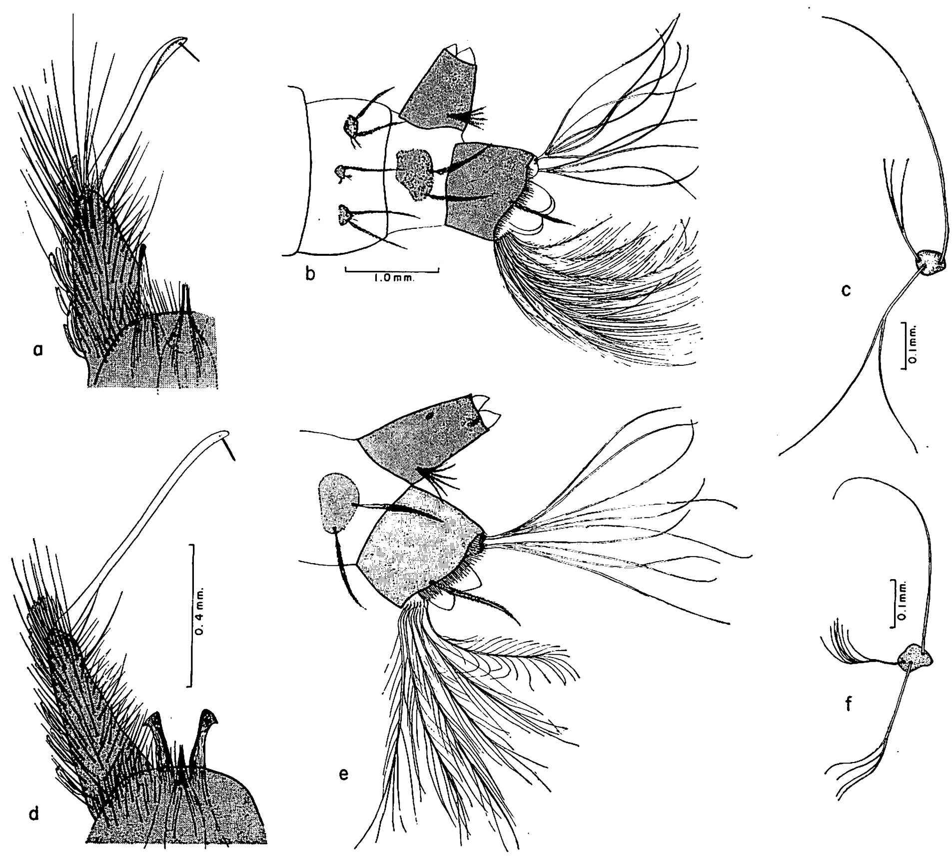

Figure 22—*Toxorhynchites brevipalpis* Theobald: **a,** male genitalia, dorsal view; **b,** posterior end of larva; **c,** prothoracic bristles 1, 2, and 3. *T. splendens* (Wiedemann): **d,** male genitalia, dorsal view; **e,** posterior end of larva; **f,** prothoracic bristles 1, 2, and 3.

margin of the segment in the male and extending over about half the lateral margin in the female. The tufts of the 8th segment are all black in the males and are yellow to orange in the females. The second tarsal segments of the males are all black. In the females the front basitarsi are all white except for a narrow band of black at bases. The middle tarsus has a broad white band over the basal two-thirds of 1st segment and segments 2–4 are entirely white. The basal two-fifths of the hind basitarsus is yellow-white. The male dististyli are more elongate than in *brevipalpis*. The genitalia also differ, as shown in figure 22d.

Length: body, 8.0–11.0 mm.; wings, 6.5–8.75 mm.

The larvae resemble those of *brevipalpis* but apparently differ by the characters pointed out in the discussion under *brevipalpis* in the key above and in figures 22e and f. I have not had an opportunity to examine enough specimens of this to be sure of the range of variation of the characters.

Subfamily CULICINAE Rondani

Culicina Rondani, 1856, Dipt. Ital., Parma, 1:37.
Culicinae Schiner, 1864, Fauna Austriaca 2:xxx.

Members of this subfamily have the proboscis elongate, flexible, and straight and the scutellum trilobed. The larvae have a well-developed siphon and have a comb on the 8th abdominal segment. This is the largest subfamily of mosquitoes. Only two genera occur in Hawaii.

KEY TO GENERA OF CULICINAE FOUND IN HAWAII

ADULTS

1. Postspiracular bristles present. Mesonotum, head, and legs with conspicuous silvery white marking...... **Aedes** Meigen.
   Postspiracular bristles absent. Mesonotum and head without white markings, densely covered with brownish yellow scales; legs not banded.................. **Culex** Linnaeus.

LARVAE (4th Instar)

1. Siphon with three pairs of ventral tufts (fig. 25b). The upper and lower frontal, preantennal, and the antennal hairs are represented by large tufts (fig. 25c)....... **Culex** Linnaeus.
   Siphon with one pair of 2–3-branched hairs situated near the middle of the segment (fig. 24b). The antennal and upper frontal hairs single, the others not more than 2-branched (fig. 24c).............................. **Aedes** Meigen.

PUPAE

1. Paddles fringed with short denticles on distal margin...... .... **Aedes** Meigen.
   Paddles smooth on margin................ **Culex** Linnaeus.

Genus **CULEX** Linnaeus

Culex Linnaeus, 1758, Systema Naturae, ed. 10:602.
Refer to Dyar (1928) or Edwards (1932) for synonyms.

Recognizable by the characters given in the above key. For further details refer to Carpenter and La Casse (1955:269) or to one of the other comprehensive works.

The eggs of *Culex* are fixed together in raft-like masses.

Only one species, *Culex quinquefasciatus* Say, occurs in the Islands.

Type of genus: *Culex pipiens* Linnaeus.

Culex quinquefasciatus Say (figs. 25a–c).

Culex quinquefasciatus Say, 1823, Jour. Acad. Nat. Sci. Phil. 3:10.
Culex fatigans Wiedemann, 1828, Ausser. Zweifl. Ins. 1:10.

See Dyar (1928) and Edwards (1932) for additional synonyms.

Some authors treat this as a subspecies of *C. pipiens* Linnaeus (see Horsefall, 1955:563).

Common on all the Hawaiian Islands.

Immigrant. Widespread throughout the warm temperate, tropical, and subtropical regions of the world. It apparently reached Hawaii about 1826 (see Van Dine, 1904:7).

Type locality: Mississippi River, U.S.A. The type has been lost.

This is the common night-biting mosquito and it is often a very troublesome domestic pest in many areas. It breeds in ditches, pools, marshes, tin cans, buckets, barrels, etc. It has a preference for stagnant waters. For a historical account and

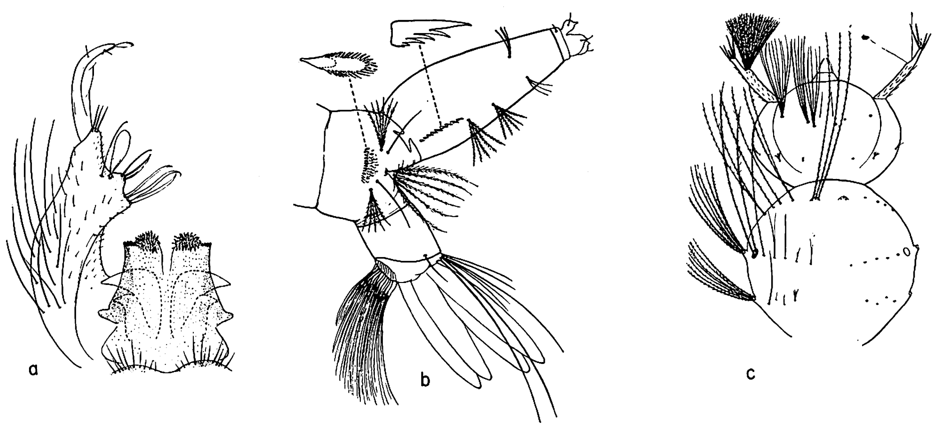

Figure 25—*Culex quinquefasciatus* Say: **a,** male genitalia, ventral view; **b,** posterior end of larva; **c,** head and thorax of larva.

an account of the economic importance of this species in the Islands, refer to the remarks made in the Introduction.

In other areas in the tropics and subtropics of the world, this species is an important vector of filariasis (*Wuchereria bancrofti*). It is a known vector of heartworm of dogs, bird malaria, and fowl pox, and is very probably capable of transmitting the virus which causes Japanese B-type encephalitis in Japan and other areas. The viruses of two of the types of encephalitis (Western equine and St. Louis) have been isolated from this species in California.

Mesonotum and head are covered with narrow, curved, yellow-brown scales. Each abdominal tergum with a band of white scales across the base, these bands convex on hind margins in the female. For the male genital characters see figure 25a. For the larval characters see figures 25b and c. Refer to Carpenter and La Casse (1955:286) or to La Casse and Yamaguti (1950:220) for more complete description.

Genus **AEDES** Meigen

Aedes Meigen, 1818, Syst. Beschr. Zweifl. Ins. 1:13.
For synonymy refer to Dyar (1928) or Edwards (1932).

Distinguished by the characters given in the above key. For further details refer to Carpenter and La Casse (1955:137) or to one of the other comprehensive studies.

The eggs of *Aedes* are laid singly.

Two species of the subgenus *Stegomyia* occur in Hawaii. These are both domestic and forest mosquitoes and are diurnal in habit. Under laboratory conditions it has been demonstrated that female *A. aegypti* can mate with male *A. albopictus* and produce fertile eggs (see Bonnet, 1950). It is evident that most of the eggs produced from such crosses are sterile. Bonnet was able to hatch only one larva out of 175 eggs. The resultant hybrid was a male with all of the characteristics of a normal *A. albopictus*.

Type of genus: *Aedes cinereus* Meigen.

Subgenus **STEGOMYIA** Theobald

Stegomyia Theobald, 1901, Mon. Culicidae 1:283.

According to Carpenter and La Casse (1955:138), the *Stegomyia* are characterized as follows: "Palpi of male as long or nearly as long as the proboscis. Male terminalia with the phallosome divided into two lateral plates, each plate bearing numerous teeth distally. Claspettes absent. Basistyle with the basal lobe present, apical lobe absent." They differ from the species of the subgenus *Aedimorphus* by having the palpi slender, upturned, and not hairy, and genital characters are different.

Type of subgenus: *Aedes aegypti* (Linnaeus) (as *fasciatus* Fabricius).

Key to Species of Aedes

ADULTS

1. Mesonotum with a silvery white stripe extending down the middle and with a pair of short submedian stripes on posterior portion. Male basistylus rather elongate, the pad-like lobe on inner margin is basal in position (fig. 24a).. **albopictus** (Skuse).

   Mesonotum with a pair of thin submedian stripes extending the entire length and with long paired anteriorly curved outer stripes in the form of a lyre (fig. 23c). Male basistylus very short and thick, the pad-like inner lobe is subapical (fig. 23a).................... **aegypti** (Linnaeus).

LARVAE (4th Instar)

1. Each comb scale spine-shaped, fringed on the sides. Ventral brush of anal segment made up of about eight simple bristles (fig. 24b).................... **albopictus** (Skuse).

   Each comb scale with several short lateral spines in addition to the apical spine. Ventral brush of anal segment made up of 8–10, single to three-forked bristles (fig. 23b).. **aegypti** (Linnaeus).

Aedes (Stegomyia) aegypti (Linnaeus) (figs. 23a–c).

Culex aegypti Linnaeus, 1762, Hass. Pal. Reise, p. 470.

Refer to Dyar (1928) or Edwards (1932) for synonyms.

Probably present on all of the main Islands but no specimens have been reported on Oahu since about 1953.

Immigrant. Widespread throughout the warm temperate, tropical, and subtropical regions of the world.

Type locality: Egypt. The type has been lost.

This species is notorious as the vector of yellow fever and dengue fever; the former disease was once the scourge of the entire Western Hemisphere and is still a dangerous threat to Central America and parts of South America and Africa where the sylvatic form of the disease is reservoired in monkeys and other primates. For information concerning the economic importance of this species in Hawaii, refer to the Introduction.

This species apparently reached Hawaii about 1895, according to Perkins' observations (Perkins, 1913: clxxxi). It is a domestic species, preferring to live near

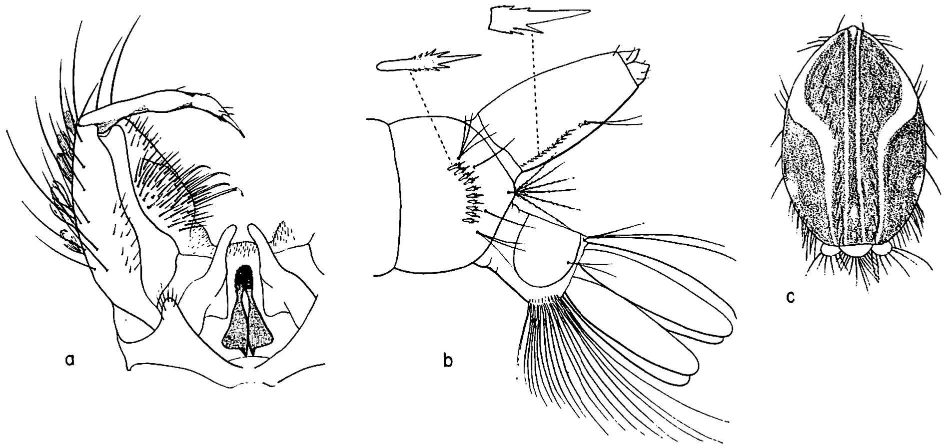

Figure 23—*Aedes aegypti* (Linnaeus): **a,** male genitalia, ventral view; **b,** posterior end of larva; **c,** mesonotum, dorsal view.

or in the habitations of man. It breeds in all sorts of artificial receptacles containing clean water: tin cans, bottles, flower vases, barrels, roof gutters, old tires and any object which will hold water. It also breeds in tree holes and in the water which collects in the leaf axils of such plants as "ape," *Alocasia macrorrhiza* (L.) Schott; pineapple lily, *Billbergia thyrsoidea* Mart., and the spider lily, *Crinum asiaticum* L. A study of the breeding sites of the day-biting mosquitoes in Honolulu was made by Dr. D. D. Bonnet (1947:43–49).

The species is readily recognized by the lyre-shaped pattern of the silvery white scales on the mesonotum (fig. 23c) and by the characteristics of the male genitalia (fig. 23a) and of the larvae (fig. 23b).

Aedes (Stegomyia) albopictus (Skuse) (figs. 24a–c).

Culex albopictus Skuse, 1894, Ind. Mus. Notes 3(5):20.

Stegomyia lamberti Ventrillon, 1904, Bul. Mus. Paris 10:552.

Aedes (*Stegomyia*) *albopictus* Skuse, Edwards, 1930, Bul. Ent. Res. 11:134.

Immigrant. Widespread throughout the Oriental and African tropics and through much of the Pacific.

Type locality: Calcutta, India.

Type in the Australian Museum.

This is predominantly a forest mosquito, especially inhabiting the wet interior sections of the Islands. It is also the common day-biter in the lowlands in situations where dense vegetation occurs. It breeds in much the same types of habitats as does *A. aegypti,* although shows a preference for tree holes, bamboo stems, and water held in leaf axils. It evidently reached Hawaii about the same time as *A. aegypti* (see Perkins 1913:clxxxi).

This species is a vector of dengue fever and heartworm of dogs (*Dirofilaria*

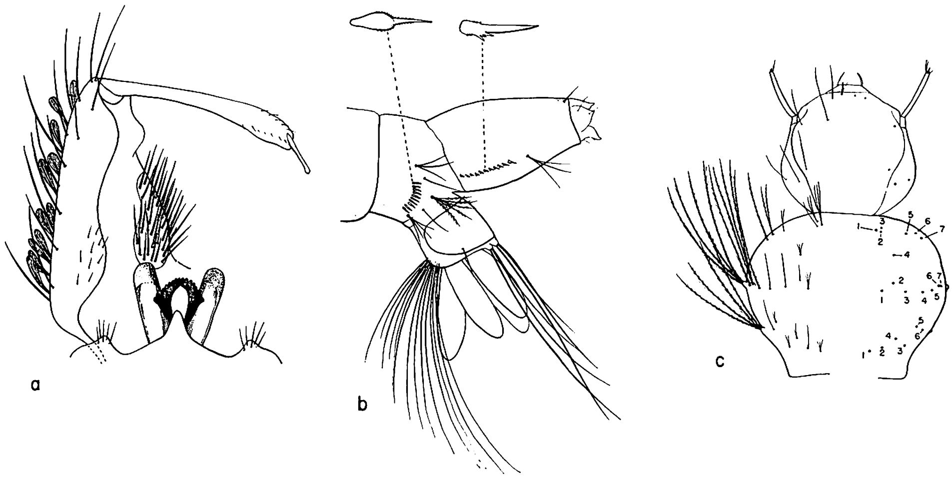

Figure 24—*Aedes albopictus* (Skuse): **a**, male genitalia, ventral view; **b**, posterior end of larva; **c**, head and thorax of larva.

immitis), and is a possible vector of Japanese B-type encephalitis.

It is readily recognized by the markings of the mesonotum and by the characteristics of the male genitalia (fig. 24a) and the larvae (figs. 24b and c). For more complete details refer to La Casse and Yamaguti (1950:111).

Family CHIRONOMIDAE Newman
Non-biting Midges

Chironomites Newman, 1834, Ent. Mag. 2:379.
Chironomides Macquart, 1838, Dipt. Exot. Nouv. ou Peu Connus 1(1):36.
Chironomidae Haliday, 1851, in Walker's Insecta Brit., Dipt. 1:7.
Eretmopteridae Kellogg, 1900, Biol. Bul. 1:82.
Tendipedidae Speiser, 1910, in Sjostedt's Wissenschaft. Ergebnisse der Schwedischen Zool. Exped. Kilimandjaro 2(10):198. Grünberg, 1910, Die Süsswasserfauna Deutschlands, Jena. Heft 2a: name cited on title page.

Moderately small, rather delicate, slender-legged insects (fig. 26), distinguished from other Nematocera by lacking ocelli, by having the metanotum elongated and usually with a longitudinal groove down the middle and the costa not continued around the wing margin (fig. 28a). Some of the larger species (*Chironomus* in Hawaii) superficially resemble mosquitoes (Culicidae) and are often mistaken for these by laymen. The midges are easily distinguished from mosquitoes by the reduced mouthparts (lack of a long sucking beak), by the costa not continuing beyond the wing tip, and by the lack of scales on the wing veins or membrane. The Ceratopogonidae were formerly included in the Chironomidae, and differ most obviously by lacking the longitudinal groove on the metanotum, by having the head rounded behind instead of flattened, and by having vein M forked. The Hawaiian species can also be readily differentiated since the costa and radial veins

end near the middle of the wing (fig. 53e); except for *Corynoneura* Winnertz, none of our Chironomidae have this type of venation. Also, when at rest, the wings of chironomids lie roof-like rather than flat over the back.

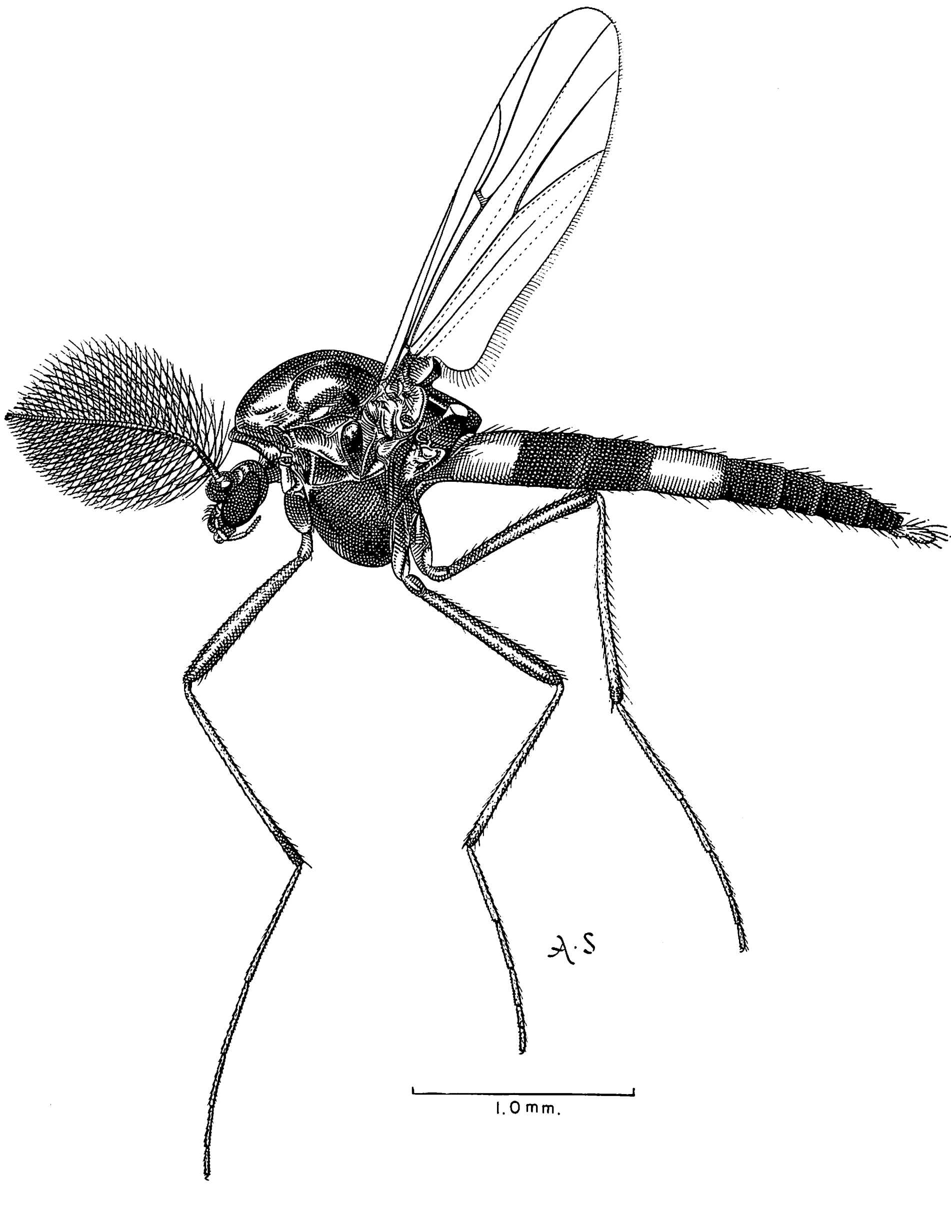

Figure 26—*Cricotopus bicinctus* (Meigen). Adult male.

The head is small and is often partially hidden beneath the projected front margin of the mesonotum. The antennae are slender, possess 5 to 14 segments and are densely plumose in the males, except for species of Clunioninae. The mouthparts are small, not fitted for piercing. The maxillary palpi are usually four-segmented, reduced to one segment in *Clunio* Haliday and two segments in *Telmatogeton* Schiner. The thorax is moderately arched as seen from the side, produced in front and with a broad longitudinal depression in the middle of the hind portion of the mesonotum. The scutellum is small, about half as long as the elongated metanotum. Legs are long and slender, often characteristically banded; the tarsi, especially of the front legs, are often very long and are important in classification as are the spines and combs of the tibiae and the development of the empodia, pulvilli, and tarsal claws. Some species hold the front legs raised up in front when resting. This characteristic apparently gave rise to the name of the type genus *Chironomus* (from the Greek chironomos, one who gestures with the hands). Rather long narrow wings are present in all of the known Hawaiian species except for females of the *Clunio*. The venation is rather variable: six to eight longitudinal veins are present (except in *Corynoneura*), the anterior veins are rather strong, and those in the posterior portion of the wing are weak. The r–m crossvein is present but sometimes is horizontal in position and may appear as an extension of R_{4+5}. The m–cu crossvein is absent (except in Tanypodinae) and media is reduced to a simple vein. The cubital vein is forked and the anal veins evanesce before reaching the wing margin. The abdomen is elongate, especially in the males, and the genitalia are exposed. The genitalia vary greatly in development in the various groups as shown in figures 32e, 34e, and 48d. The Hawaiian species range in size from 0.6 mm. body length in *Orthocladius conjunctus* (Edwards) to 10.0 mm. in *Telmatogeton hirtus* Wirth.

The immature stages are passed in water or in very wet habitats. The majority of the Hawaiian species apparently breed in a wide variety of fresh and salt water habitats. Members of the genera *Orthocladius* and most *Metriocnemus* (possibly all of the Orthocladiinae in Hawaii excepting *Cricotopus*) are obviously terrestrial, having been reared from roots of plants and from mosses. *Chironomus hawaiiensis* Grimshaw is the well known "blood worm" of Hawaii; it breeds abundantly in fresh water habitats ranging from reservoirs, ponds, and ditches, to fish bowls. Most of our aquatic species are bottom feeders in ponds, reservoirs, slow moving streams, and similar quiet water conditions. Members of the genus *Telmatogeton* occupy the opposite type of situation, living only in swift, well-aerated waters ranging from torrential mountain streams to the wave-drenched rocks of the sea-coast. The larvae are elongate, cylindrical, and worm-like with well-developed prolegs on the prothorax and on the posterior end. The aquatic species (in Hawaii) are probably herbivorous, feeding on algae, microscopic aquatic life (plankton), and small particles of decaying vegetable matter. The terrestrial forms evidently feed as scavengers on decaying vegetation, as herbivors on mosses, and on the roots of other plants and possibly some as predators on other small animals. No life history studies have been done on any of the terrestrial species in Hawaii. Williams (1944) gives a few notes on habits of some of the species and also gives

some excellent life history studies of some of the aquatic species. Wirth (1947b and 1947c) presents the most complete accounts of the biologies of Hawaiian *Thalassomya* and *Telmatogeton*. For generic keys for larvae and pupae see Wirth and Stone (1956:410–412). The eggs of most of the aquatic species (excluding Clunioninae) are laid in gelatinous strings or ribbons, which may in turn be imbedded within a nearly transparent jellylike mass. The bottom-living species (mainly Chironominae) often contain haemoglobin within the bodies of the larvae for storage of oxygen; this accounts for their blood-red color. The larvae which live nearer the surface are usually greenish or whitish. The pupae vary a great deal in structure; those which live in deeper water or in the bottom mud lack respiratory trumpets but instead absorb their oxygen supply through finely branched, filamentous, gill tufts. The tracheal system, contrary to that of the larvae, is well developed and when the adult is ready to emerge the tracheae are filled with air through the gill filaments and the puparium floats upwards to the surface. For discussions of the immature stages refer to Johannsen (1937a and 1937b), Wirth and Stone (1956), and Lenz (1936, 1939, 1950, and 1954).

The adults are most often collected on vegetation near water, dancing in swarms at dusk or in shady places along the mountain trails in the daytime, or attracted to lights at night. Species of *Telmatogeton* are found running about on the spray-drenched rocks along swift moving mountain streams or along the seacoast and other Clunioninae are found on the seacoast, running about erratically over the wet rocks where they are breeding, or hiding in rock crevices near the low-tide level or in intertidal pools. Very few observations have been made concerning the swarming habits of the Hawaiian chironomids. It is probable that most species do swarm during the mating period. Large numbers of males may sometimes be seen dancing up and down, and as individual females invade the swarm, mating takes place and the pairs drop to the ground or to adjacent foliage.

Midges are rather difficult to take care of in the field since they are so fragile. Unless given special attention immediately after collecting, specimens reach the laboratory in such poor condition that they are often practically worthless. Whenever possible the specimens should be removed from the killing jar as soon as they are dead and layered carefully in pill boxes. Edwards (1929b:281) and Coe (1950:123) state that in order to obtain good material for study it is essential that midges should either be pinned in the field or brought back to the laboratory alive in pill boxes or vials. This would not be practical, however, for the average collector; but it certainly is advantageous to put them on nadeln or paper points as soon as possible after killing. Some workers have recommended preserving specimens in alcohol, but I have found specimens in fluid to be more difficult to identify. These flies are easily reared in the laboratory and to obtain the best specimens it is recommended that larvae be collected by taking bottom samples of mud, masses of aquatic vegetation, algae growth, etc. and straining (washing) the larvae out into a shallow white pan. The mature larvae may be recognized by the subtriangular black rudiments of the adult eyes on each side just back of the larval head. Some species of Chironominae have greatly enlarged chromosomes

in the salivary glands of the mature larvae and are important insects in cytogenetic research.

Midges of various kinds are apparently a favorite food of dragonflies (Warren, 1915:73 and Williams, 1936b:284, 289) and other predators. Williams (1944:158) found that they were preyed upon by water beetles, bugs, crustacea, fish, and predaceous flies, and he reports (1931b:275) that *Chironomus hawaiiensis* forms a considerable part of the food of some lizards (Geckos). Needham (1950) reported that midge larvae (probably mostly chironomids belonging to the genus *Telmatogeton*) are very important as food of fresh-water fish in Hawaii. Food habit studies of some of the reef fish and fish of the intertidal pools have also shown that the marine midges are an important source of food.

Considerable differences of opinion exist among the specialists on this family concerning the generic and subgeneric concepts, especially in the subfamily Orthocladiinae (Hydrobaeninae of many authors). It is probable that some of the concepts followed in this work will have to be modified when more complete studies have been made. For the most recent taxonomic studies of this family refer to the following: Freeman (1955, 1956); Brundin (1947 and 1956); Johannsen (1946a, 1946b, and 1952); Townes (1945, 1952); Wirth (1947c, 1949); Wirth and Stone (1956); Stone and Wirth (1947); Coe (1950); Goetghebuer (many papers from 1932–1950); and Strenzke (1950).

Key to Subfamilies and Genera of Chironomidae

1. Crossvein m–cu absent 2

   Crossvein m–cu present; wings densely hairy (fig. 35a). Tanypodinae .... **Pentaneura** Philippi.

2(1). First joint of tarsus longer than tibia, at least half again as long. Front tibia without a distinct spur. Claspers of male rigidly extended behind, not folded inward (fig. 32f). Chironominae 3

   First joint shorter than tibia. Front tibia with a distinct spur 5

3(2). Wing membrane hairy. Squama without a fringe of hairs. Crossvein r–m nearly parallel to and practically continuous with R_{4+5} .... **Calopsectra** (**Tanytarsus**) van der Wulp.

   Wings bare. Squama with a marginal fringe of long hairs. Crossvein r–m oblique 4

4(3). Male antennae 12-segmented. Frontal tubercles present (fig. 31c). Combs of mid and hind tibia each with a short spine (fig. 31e). Wings without markings...... .... **Chironomus** Meigen.

Male antenna 14-segmented. Frontal tubercles absent. Inner comb of middle tibia and outer comb of hind tibia with a spine, the others unarmed (figs. 34b–c). Wings spotted (fig. 34a) . . . . **Polypedilum** Kieffer.

5(2). Pronotum entire, or with just a small V-shaped cleft in the middle. Anepisternal suture (between sterno- and mesopleura) well marked, almost reaching front coxa. Metanotum with a distinct median furrow. Male antenna plumose (fig. 37f) and consisting of 13 or 14 segments. Orthocladiinae 6

Pronotum widely divided into lateral lobes; anepisternal suture very short or absent. Male antenna (fig. 47a) almost bare, consisting of not more than 11 segments. The metanotum without a distinct median furrow or keel. The front flattened and developed platform-like above eyes and antennae. Also the wings are distinctly gray, milky, or brown (marine or in swift mountain streams). Clunioninae 9

6(5). Wing membrane devoid of macrotrichia 7

Wing membrane with macrotrichia . . . . **Metriocnemus** van der Wulp.

7(6). Radius completely fused with the thickened costa and reaching not more than two-thirds the wing length; a false vein extends close to the anterior margin on outer half of the wing (fig. 36a). Hind tibia distinctly swollen at tip, obliquely truncate and with a conspicuous apical projection on inner side (fig. 36d). Corynoneurinae . . . . **Corynoneura** Winnertz.

Radius not completely fused with costa and reaching at least three-fourths of wing length; no false vein 8

8(7). Abdomen conspicuously banded with yellow (fig. 26). Dorsocentral hairs minute, decumbent, not arising from obvious punctures. Eyes densely pubescent. Squama completely fringed . . . **Cricotopus** van der Wulp.

Not as above. Dorsocentral hairs conspicuous and arising from distinct punctures. Eyes bare. Squama with not more than median margin fringed . . . . **Orthocladius** van der Wulp 8a

8a(8). Squama bare . . . . **Orthocladius** (**Smittia**) Holmgren.

Squama with long hairs in the middle of hind margin . . . . **Orthocladius** (**Orthocladius**) van der Wulp.

9(5). Squama densely haired on margin. Legs slender. Wings rather narrow, three to four times longer than wide,

not strongly petiolate (fig. 50a) and gray-brown or black-fumose. Male genitalia moderately developed. Antennae 7-segmented. Palpi 2- to 4-segmented.......10

Squama bare. Legs stout, basitarsi one and a half to three times longer than wide. Wings of male broadly rounded and petiolate, not over two times longer than wide (fig. 47b) and milky white. Females wingless. Basistyli of male tremendously enlarged (fig. 48d). Antennae of male 11-segmented. Palpi 1-segmented............................**Clunio** Haliday.

10(9). Fifth tarsal segment deeply trilobed (fig. 50c). Palpi short, 2-segmented. Crossvein r–m situated near middle of wing...............**Telmatogeton** Schiner.

Last tarsal segment not divided into lobes. Palpi elongate, nearly two times longer than antennae, 4-segmented. Crossvein r–m near basal third of wing.... ....**Thalassomya** Schiner.

Subfamily Chironominae Skuse

Chironomina Skuse, 1889, Proc. Linn. Soc. N. S. Wales (2) 4:222.
Chironominae F. Lynch Arribalzaga, 1893, Bol. de la Acad. Nac. de Ciencias en Cordoba, p. 220.
Chironomini Handlirsch, 1925, in Schröder's, Handbuch der Ent. 3:970.
Tendipedinae Townes, 1945, Amer. Mid. Nat. 34:12.

The members of this subfamily are characterized by having the basitarsi of the front legs very long and slender (longer than the tibiae as in figure 30e). Also, the dististyli of the male genitalia are directed rigidly backwards (fig. 31g), not folded inwardly as in other groups.

According to Johannsen (1937a:4) the larvae of Chironominae are differentiated from those of Orthocladiinae and Clunioninae by presence of the paralabial plates; the mandibles usually possess a preapical comb, and the maxillary palpi are more elongate. The pupae are differentiated by the presence of spines or a comb on each posterolateral angle of the preanal segment, and the thoracic respiratory organs are usually represented by a tuft of filaments, or, if simple, the lobes of the anal segment have a fringe of slender filaments. Refer to Johannsen and to Wirth and Stone (1956:417–419) for more details and for figures.

Three genera are represented in Hawaii: *Chironomus* Meigen, *Calopsectra* Kieffer, and *Polypedilum* Kieffer.

Genus **CALOPSECTRA** Kieffer

Calopsectra Kieffer, 1909, Bull. Soc. Hist. Nat. Metz 26:50.
Tanytarsus, of authors.

As pointed out by Townes (1945:11), the group called *Tanytarsus* by recent authors should go under the name *Calopsectra* Kieffer. The type of the genus *Tanytarsus* van der Wulp is *Chironomus punctipes* Wiedemann, selected by Coquillett (1910:612); Edwards (1929b:375), and other authors have preferred to consider *Tanytarsus signatus* van der Wulp as the type on the grounds that Kieffer (1909:50) had already restricted *Tanytarsus* to those species without pulvilli. This should have no bearing, however, since *punctipes* was the first selected type. This interpretation will place *Tanytarsus* Wulp in the tribe Chironomini since the squama is fringed with long hairs and the r–m crossvein is oblique in position; *Calopsectra* Kieffer, based upon *C. gregarius* Kieffer, fits in the tribe Calopsectrini because the squama is without a fringe of hairs and the r–m crossvein is nearly longitudinal in position, thus apparently continuous with the base of R_{4+5}. We apparently have no true *Tanytarsus* in Hawaii; the species which have been referred here in our literature belong in *Calopsectra.*

Calopsectra are separated from other Chironominae in Hawaii by the hairy wing membrane and the crossvein r–m nearly parallel to, and practically continuous with, R_{4+5}; the squama is bare, the anal area is reduced, and no well-developed anal lobe is present. Also the male genitalia are distinctive because of the presence of two accessory appendages (fig. 27). Our species also differ from *Chironomus* by their very small size, the lack of tibial spurs, the presence of a strong anteroventral spur at apex of each mid and hind femur (fig. 28c), and the front portion of the mesonotum more produced covering over the pronotum and hiding it from dorsal view. Edwards (1929b:411) and Coe (1950:200) treat this as a group under the subgenus *Tanytarsus* and Goetghebuer (1938:127) treats it as a subgenus of *Tanytarsus.*

All of the Hawaiian species apparently fit in the subgenus *Micropsectra* Kieffer.

According to Johannsen (1937a:5) the larvae of this group (as "*Tanytarsus*") differ from those of other Chironominae by "their rather long five-segmented antennae, the basal segment of which is somewhat curved, is about twice as long as the remaining segments combined, and is mounted on a tubercle or prominence." The eggs "are covered with a gelatinous sheath which in turn may be embedded in a gelatinous mass."

Subgenus **MICROPSECTRA** Kieffer

Micropsectra Kieffer, 1909, Bul. Soc. Hist. Nat. Metz 26:50.
Eutanytarsus Bause, 1914, Arch. Hydrob. Planktonk., Suppl., 2, fasc. 1:120.
Syntanytarsus Bause, 1914, Arch. Hydrob. Planktonk., Suppl., 2, fasc. 1:120.

Members of this subgenus are characterized by having the tibial combs of the middle and hind legs confluent ventrally and with no spurs developed (fig. 30b). This is treated as a genus under Tanytarsini by Goetghebuer (1938:84). Edwards (1929b:407), Coe (1950:196), and Johannsen (1952:25) treat it as a subgenus.

Type of subgenus: *Micropsectra inermipes* Kieffer (*praecox* Kieffer).

Key to Known Species of Calopsectra (Micropsectra) Kieffer in Hawaii

1. Legs brown with at least basitarsi conspicuously banded with white or entirely white. Male antenna 14-segmented. Superior appendages not enlarged at apices. Predominantly black species 2
   Legs yellow, not banded. Male antenna 13-segmented. Superior appendages capitate (fig. 28e). At least scutellum pale colored . . . . **hawaiiensis n. sp.** 1a

1a. Greenish or yellowish species . **hawaiiensis hawaiiensis n. sp.**
   Thorax chiefly black, abdomen brown to black . . . . **hawaiiensis albifasciata n. subsp.**

2. Basitarsi banded with white and brown 3
   Basitarsi entirely white . . **lacteiclavus latifasciata n. subsp.**

3. Basitarsi brown at apices and with broad white basal bands . . 3a
   Each basitarsus with a narrow white band at apex and at base 4

3a. Basal four-fifths of front basitarsus white and basal three-fourths to four-fifths of middle and hind basitarsi white . . . . **kaalae n. sp.**
   Basal one-half of front basitarsus white and approximately basal third of middle and hind basitarsus white . . . . **kaalae monticola n. subsp.**

4. Anterior third of mesonotum yellow. Distinct white bands at apices of all tarsal segments. Abdomen yellow with brown to black apical bands . . . . **bryanti n. sp.**
   Mesonotum all black; only basitarsi distinctly banded; abdomen not banded . . . . **lacteiclavus** (Grimshaw).

Calopsectra (Micropsectra) bryanti, new species (fig. 27a–b).

Very close to *C. lacteiclavus* (Grimshaw), differing by having the front portion of the mesonotum yellow rather than brown to black; also by having all of the tarsi with distinct apical white bands and with a distinct white band at the base of each tibia. In *lacteiclavus* only the basitarsi are distinctly banded; the bases of the tibiae are sometimes slightly paler than the rest of the segment. The abdominal segments of *bryanti* are predominantly yellow with distinct brown to

black bands across the apices of the terga, rather than being unicolorous as in *lacteiclavus*. Also the genital characters are very distinctive as shown in figure 27b. The most striking differences are in the much stronger developed accessory appendages of *bryanti;* these extend beyond the apex of the anal point. Also the ventral lobe of the superior appendage is very short, ending well before the apex of the dorsal lobe.

MALE. *Head:* Brown except for the compound eyes. Palpi brown, tinged with yellow. Scape of antenna brown, the remainder yellow. The apical segment is slightly more than one-half as long as the remainder of the antenna. *Thorax:* Mesonotum highly arched so the head is placed at a level with a line drawn longitudinally through the middle of the pleura. The anterior third of the mesonotum is entirely yellow, the remainder is dark brown to black. The pronotum is yellow, tinged with brown in the median portion. The pleura are dark brown to black except for the yellow propleura. *Legs:* Largely brown, faintly tinged with yellow. The front basitarsi are one-half longer than the tibiae. The confluent tibial combs occupy about half the circumference of the segment. All the tibiae have narrow white bands at their bases. The bases and apices of basitarsi are white banded and the other tarsal segments have narrow white bands at their apices. The basal bands on the front basitarsi occupy about two-fifths the length of the segment, on the other legs they are about one-third the length of the segment; those at the apices are much narrower, occupying less than one-fifth the length of the segment. *Wings:* Faintly gray, bases white. The fork of cubitus situated beyond the r–m crossvein. *Abdomen:* Largely yellow with brown to black rings across the apices of the terga. *Genitalia:* Brown with conspicuous yellow-white appendages. The dististyli are rather parallel-sided and about equal in length to the basistyli. The ventral lobes of the superior appendages are small and inconspicuous, ending well before apices of the dorsal lobes. The accessory appendages extend approximately three-fourths the distance to the apices of the inferior appendages and have flat, scale-like setae around apices, especially on the outer margins. The anal point is well developed but does not reach the tips of the accessory appendages (fig. 27b).

Length: body and wings, 2.2–2.5 mm.

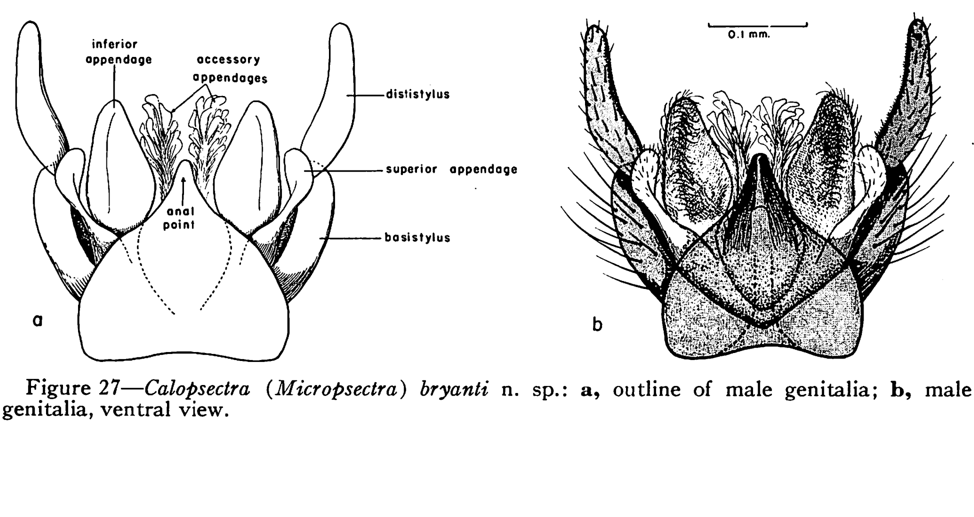

Figure 27—*Calopsectra* (*Micropsectra*) *bryanti* n. sp.: **a**, outline of male genitalia; **b**, male genitalia, ventral view.

FEMALE. Fitting the characteristics of the male except for sexual characters. Also the thorax is somewhat more yellowish tinged in the ground color. The area immediately in front of scutellum is often yellow, tinged with brown. The sixth antennal segment is one-half longer than the fifth.

Holotype male: Olinda, Maui, 4,500 ft. elevation; April 8, 1932 (O. Bryant). Allotype female: Kula Pipeline, Maui, 4,500 ft.; March, 1932 (O. Bryant). Six paratypes (three males same as type; one female, one male, same as allotype); and one male, Haleakala, Maui, 7,000 ft., "in crater on Coprosma"; March 22, 1932 (O. Bryant).

This species is named after Mr. O. Bryant, who collected extensively in the Islands during 1932.

The type, allotype, and two paratypes are in the collection of the B. P. Bishop Museum. The remainder are being deposited in the U. S. National Museum and the University of Hawaii collections.

Calopsectra (Micropsectra) hawaiiensis, new species (figs. 28a–f).

Metriocnemus sp., Illingworth, 1929, Proc. Haw. Ent. Soc. 7:233. Specimens were misidentified as this by Aldrich. I have seen the series in the B. P. Bishop Museum.

Tanytarsus lacteiclavus Williams (*nec* Grimshaw), 1944, Proc. Haw. Ent. Soc. 12:116.

Metriocnemus sp., Bryan, 1944, Proc. Haw. Ent. Soc. 8:405, 446.

This small, pale-green midge is commonly observed hovering in swarms over the mountain streams. It also occurs abundantly in lowland reservoirs, lily and fish ponds, ditches, water tanks, and all sorts of artificial receptacles which hold water long enough for the immature stages to develop. Williams has published notes on the habits and life history of this species (1944:160–162). He observed that the females may on occasions reproduce parthenogenetically; a number of females were captured immediately after emergence and were found to lay viable eggs. The larvae and pupae are glassy green; the former construct tubes of debris on the bottom of the habitat. The adults are apparently able to escape from the pupal case immediately after it reaches the surface of the water. Williams found the entire transformation at the surface "was a matter of from 17 seconds to a little more than a minute." This would give the fly distinct advantage in escaping some of the surface predators. Because of their abundance these flies serve as prey for dragon flies and damsel flies, aquatic bugs, beetles, and fresh-water fishes. I believe this species is quite obviously an immigrant.

C. hawaiiensis probably resembles *Tanytarsus hopkinsi* Edwards from Samoa; at least in coloration. The latter species, however, would fit into a different subgenus by having a long outer spur on the comb of each hind tibia. Also the structural details of the antennae, the distance between eyes, and other characteristics given by Edwards differ considerably.

MALE. The living specimens are predominantly pale green, sometimes yellowish green. After death they usually turn brownish yellow. *Head:* Entirely yellow,

including appendages, but excluding compound eyes. The distance between the eyes is approximately one-half times greater than the width of one scape. The antennae are moderately plumose, consisting of thirteen segments; segment 13 is about half as long as the remainder of the flagellum (fig. 28d). Eyes bare. *Thorax:* Yellow with three indistinct brownish yellow vittae. All pile pale, hairs on dorsocentral row and on scutellum elongate, those on scutellum nearly two times the length of the sclerite. *Legs:* Entirely yellow, segments slender. Front basitarsi about one-third longer than the tibiae. The combs of mid and hind tibiae confluent on the venter, occupying about one-half the circumference and with no observable spines present. *Wings:* (fig. 28a) rather slender, distinctly gray fumose and densely covered with microchaetae. Vein R_{4+5} ends about opposite the tip of Cu_1. The fork of Cu is beyond the base of the r–m crossvein. The costa ends at the tip of R_{4+5}. The squamae are bare. *Abdomen:* Usually retaining the yellowish green coloration even in dry specimens. *Genitalia:* The dististyli are rather pointed at apices and about equal in length to the basistyli. The ninth tergum, not counting the anal point, is nearly quadrate, just slightly wider than long. The anal point is about one-third as long as dististyli (fig. 28e). The superior appendages are strongly capitate, rather pointed on inner apices and with a fringe of fine hairs along each inner edge, these extend nearly as far as the inferior appendages. The inferior appendages are rounded at apices, extending just beyond bases of dististyli and with long setae at apices and along inner edges (fig. 28f). The accessory appendages are short, densely setulose, and about equal in length to the anal point.

Length: body, 1.7–2.0 mm.; wing, 1.4–1.7 mm.

FEMALE. Essentially fitting the description of the male except for sexual characters. The antennae are six-segmented; segments 2 to 5 have short necks, those of 2 to 4 are approximately one-third the length of the node. The last segment is about one-third longer than the fifth (fig. 28b).

Holotype male and allotype female: Manoa Valley, Oahu, near falls; Sept., 1952 (D. E. Hardy). About 75 paratypes (about three-fourths males) from the following localities: same as type, several different months (W. W. Wirth, D. E. Hardy, M. S. Adachi); Honolulu, Dec., 1927, to Oct., 1955 (O. H. Swezey, F. X. Williams, D. E. Hardy and B. L. Defibaugh); Mt. Tantalus, Oahu, May, 1950, (D. E. Hardy); Waipio, Oahu, Sept., 1955 (D. E. Hardy); Pupukea trail, Oahu, Sept. 9, 1955 (D. E. Hardy); Mt. Kaala, Oahu, Nov., 1945 (W. W. Wirth); Kaluanui Val., Feb., 1931 (F. X. Williams) and May, 1946 (W. W. Wirth); Haleauau, Waianae, Oahu, Jan., 1932 (F. X. Williams); Hering Val., Oahu, July, 1932 (F. X. Williams); Waialua, Oahu, Jan., 1930 (O. H. Swezey); Wheeler Field, Oahu, Jan., 1946 (W. W. Wirth); Nauhi Gulch, Hawaii, 5,000 ft., Oct., 1931 (F. X. Williams); Onomea, Hawaii, July, 1932 (F. X. Williams); Honokaa, Hawaii, Oct., 1931 (F. X. Williams); Akaka Falls, Hawaii, Mar., 1946 (W. W. Wirth); and Kula Pipeline, Maui, Mar., 1932 (O. Bryant). I also have specimens in alcohol from Alakai Swamp, Kauai, 4,000 ft., Aug., 1953 (D. E. Hardy). These are not being designated as paratypes.

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. Para-

12 4

types deposited in the following collections: U. S. National Museum, British Museum (Nat. Hist.), Hawaiian Sugar Planters' Association, and the University of Hawaii.

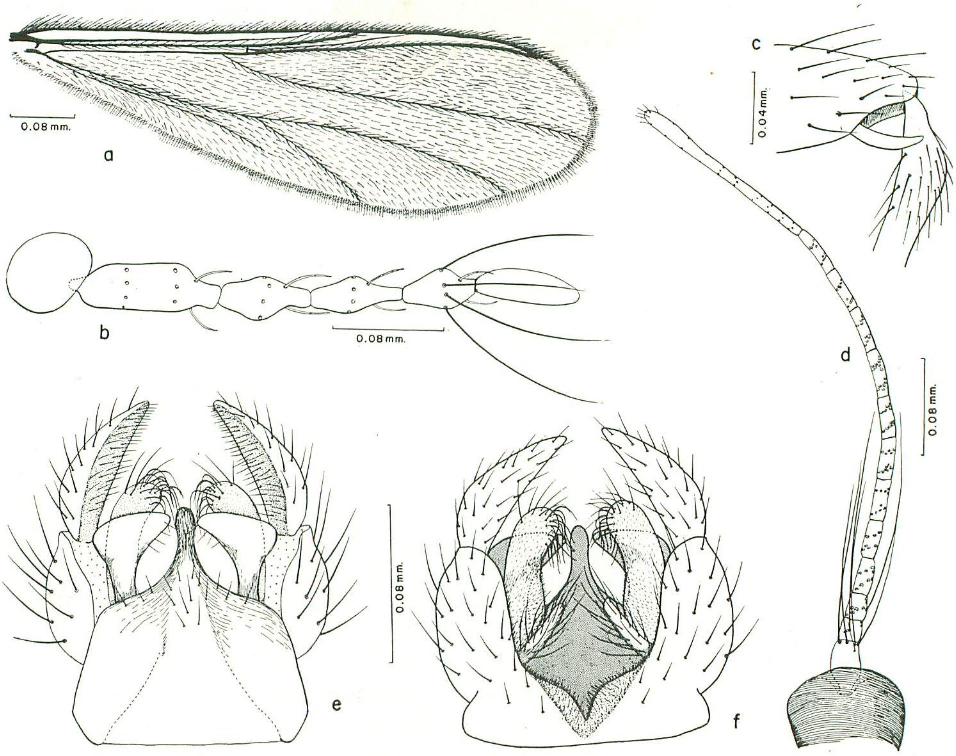

Figure 28—*Calopsectra* (*Micropsectra*) *hawaiiensis* n. sp.: **a,** wing; **b,** antenna of female; **c,** apex of middle femur; **d,** male antenna; **e,** male genitalia, dorsal view; **f,** male genitalia, ventral view.

Calopsectra hawaiiensis albifasciata, new subspecies.

This differs from the typical form by having the mesonotum, metanotum, and pleura predominantly black. I see no significant differences in the male genitalia. For the most part fitting the description of typical *hawaiiensis*. The mesonotum is black except for the front corners and an area immediately in front of scutellum. The scutellum and halteres are entirely yellow. Abdomen brown to black in the

specimens at hand, probably greenish in living specimens. The wing venation, genitalia, and other details are as in the typical species.

Holotype male: Wailuaiki, Maui; July 3, 1920; (E. H. Bryan, Jr.) Allotype female: Kula Pipeline, Maui, 4,500–5,000 ft.; March 19, 1932 (O. Bryant). Seven paratypes; two males same as type; three females same data as allotype; one female, Olinda, Maui, 4,500 ft., April 8, 1932 (O. Bryant); and one male from Nauhi Gulch, Hawaii, 5,000 ft., Oct. 2, 1951, "over stream" (no collector given), det. *Tanytarsus* sp. n.? by Edwards, 1932. A series of specimens (about 10) in alcohol and 8 on slides from Mt. Kaala, Oahu, April, 1946, 4,000 ft., "resting under leaves at stream" (W. W. Wirth) are also on hand. These are not being indicated as paratypes since I cannot be sure of the original coloration.

The type, allotype, and two paratypes are in the B. P. Bishop Museum. The remainder are in the U. S. National Museum and the University of Hawaii collection.

Calopsectra (Micropsectra) kaalae, new species (figs. 29a–c).

Resembling *C. lacteiclavus* (Grimshaw) but the basitarsi have no apical white bands and the bands at their bases are very broad. Also, the male genitalia are quite different. The most striking difference is in the elongate accessory appendages, which extend approximately to the apex of the anal point in *kaalae;* in *lacteiclavus* these are rather short, not extending over half way to apex of anal point. Specimens from on top of the mountains on Molokai and Maui seem to represent a distinct subspecies distinguished by the narrower white bands on the basitarsi. There seem to be some genital differences but these are rather slight and may be due to slight distortions or differences in positions of the parts brought about during the mounting process. See discussion under *C. kaalae monticola* n. sub. sp.

MALE. *Head:* Predominantly black, the appendages brown. The distance between the eyes equal to the width of the scape. The compound eyes narrowed to five rows of facets on each side of the front. The upper front and vertex with nine to ten strong setae on each side just above eye margin. The antennae are fourteen-segmented, densely plumose, with the apical segments rather indistinctly defined. The last segment is equal in length to segments 5 to 13, inclusive. The palpi are four-segmented, the last segment nearly two times the penultimate segment. Clypeus strongly bristled. *Thorax:* Chiefly black, anterior corners of mesonotum yellow. Pleura tinged with yellow, halteres entirely pale yellow. *Legs:* Predominantly brown, the basal four-fifths of the front basitarsi white, the basal three-fourths of the other basitarsi are white, the remainder of the segments are brown. The front basitarsi are two-thirds times longer than the tibiae. The combs of the middle and hind tibiae are confluent ventrally and extend slightly more than half the circumference of the segment. *Wings:* Slightly gray hyaline, white at bases. The fork of cubitus is just slightly below a point opposite the apex of the r–m crossvein (fig. 29a). *Abdomen:* Dark brown to black, subopaque. *Genitalia:* The appendages are conspicuously white (the details of the genitalia are taken from a paratype specimen mounted on a slide). The ninth tergum is rather triangular

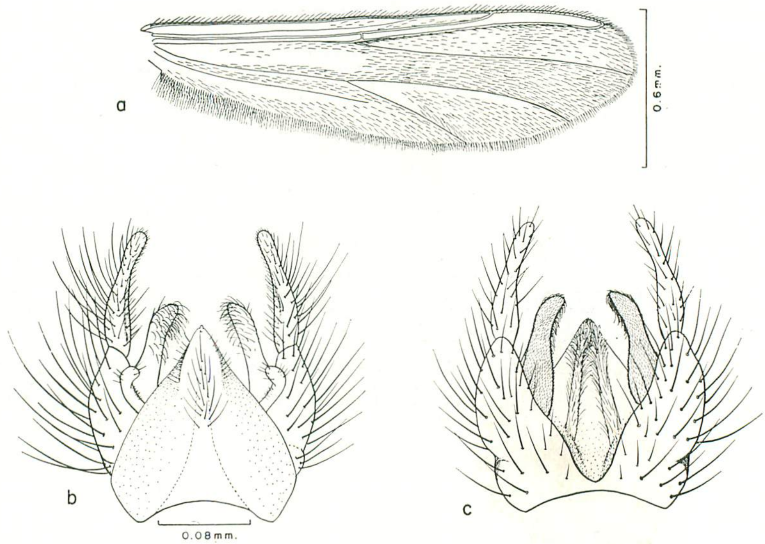

Figure 29—*Calopsectra* (*Micropsectra*) *kaalae* n.sp.: **a,** wing; **b,** male genitalia, dorsal view; **c,** male genitalia, ventral view.

in shape and has a clump of about 15 strong setae in median portion. The anal point is somewhat produced, is truncate at apex and extends about four-fifths the distance to the apices of the inferior appendages (fig. 29b). The dististyli are approximately equal in length to the basistyli. The accessory appendages are slender and rather elongate, extending approximately to the tip of the anal point and with peculiar scale-like setae around the apical portions (fig. 29c). Each superior appendage is divided into two lobes; the dorsal lobe is broad and blunt possessing two setae at apex, the ventral lobe is slender.

Length: body, 2.0 mm.; wings, 1.8 mm.

FEMALE. Fitting the description of the male except for sexual characters. The antennae are six-segmented; segments 2 to 5 have rather well-developed necks, these are about one-third as long as the nodes. The apical segment is one-half longer than the penultimate segment.

This is the species which was recorded in the literature as *Tanytarsus* sp. by Wirth (1946:491). It has been taken only on Mt. Kaala. Wirth reported it swarming beside the trail at the summit of the mountain.

Holotype male: summit, Mt. Kaala, 4,000 ft.; July 25, 1946 (W. W. Wirth). Allotype female: same data as type. Forty-two paratypes: all males; same data as type, except that two specimens were taken November 4, 1945.

Type, allotype, and most of the paratypes returned to the U. S. National Museum. The remainder have been deposited in the collections of the B. P. Bishop Museum, British Museum (Natural History), Hawaiian Sugar Planters' Association, and the University of Hawaii.

Calopsectra kaalae monticola, new subspecies.

Differing from the typical form by having the basal half of the front basitarsus white and the mid and hind basitarsi white on about the basal third of the segment. In *kaalae kaalae* the front basitarsus is predominantly white, being darkened only on the apical one-fourth to one-fifth and about the apical fourth of each mid and hind basitarsus is brown. The genitalia are similar to those of the typical subspecies with but slight differences in the shapes of the dististyli, the anal point, and other parts; these are probably not constant.

Holotype male, allotype female, and nine paratypes (all males), from Puu Kolekole, Molokai, 3,600 ft.; July, 1953 (D. E. Hardy and M. Tamashiro). Also, a series of about a dozen specimens in alcohol.

The type, allotype, and some of the paratypes are in the B. P. Bishop Museum. The remainder are being distributed in the collections of U. S. National Museum, the Hawaiian Sugar Planters' Association, and the University of Hawaii.

Calopsectra (Micropsectra) lacteiclavus (Grimshaw) (figs. 30a–e).

Tanytarsus lacteiclavus Grimshaw, 1901, Fauna Hawaiiensis 3:5.

Endemic. Kauai (Type locality: "Koholuamano"), Oahu (Mt. Kaala). The correct spelling of the type locality is Kaholuamanu.

Type in the British Museum (Natural History).

This species has been badly confused in our literature, probably due to Williams' misidentifying our common pale-green midge as *Tanytarsus lacteiclavus*. It was recorded by Wirth (1946:491) as *Tanytarsus* sp. with narrow bands on tarsi, from Mt. Kaala. I have studied his specimens. All of the specimens in the collections in Hawaii under the name *lacteiclavus* were found to be incorrectly placed.

This is a predominantly dark brown to black species, easily recognized by the narrow white bands on the bases and apices of the metatarsi, the yellow-white appendages of the male genitalia, as well as by the characteristics of the genitalia as described and figured.

Eyes bare, distance on front between eyes about equal to the width of one scape. Male antennae densely plumose, the apical segment (14th) about equal in length to that section of the flagellum from segments 8 to 13, inclusive (fig. 30a). All pile dark colored. Thorax and abdomen opaque brown to black, halteres yellow-white. Legs mostly brown, all tibiae very narrowly gray-white at bases. The white bands at apices and bases of basitarsi are about one-sixth as long as the segment on the front legs (fig. 30e) and one-third to one-fourth as long on the other legs. The second tarsal segment of the front legs also has a narrow white band at apex. The other segments are all brown to black, sometimes faintly paler at extreme apices. The combs of middle and hind legs are as in figure 30b. Wings largely gray fumose, hyaline at bases, rather narrow and densely haired. Fork of cubitus just beyond level of r–m crossvein. Apex of R_{4+5} opposite tip of Cu_1. Costa ending at apex of R_{4+5}. Squamae bare. Ninth tergum of male rather triangular; anal point tapered gradually (fig. 30c). Superior appendages bilobed, with three rather long subapical setae on inner side and a few short setae at about apical third on the

outer side of dorsal lobe. The dorsal lobe is rather broad and blunt, the ventral lobe is slender. The accessory appendages are densely haired, lie hidden beneath the ninth tergum, and do not extend to the apex of the tergum. The inferior appendages extend just beyond basistyli, are blunt at apices, slightly notched just before apex on outer edge, and very sparsely setulose. The dististyli are slender, somewhat thickened basally, tapered to apices, and about equal in length to the basistyli (fig. 30d).

Length: body, 2.0–2.2 mm.; wings, 1.8 mm.

I have seen about three dozen specimens from the highlands of Kauai; the type locality, Kokee; and "Waialae River 4,000 ft."

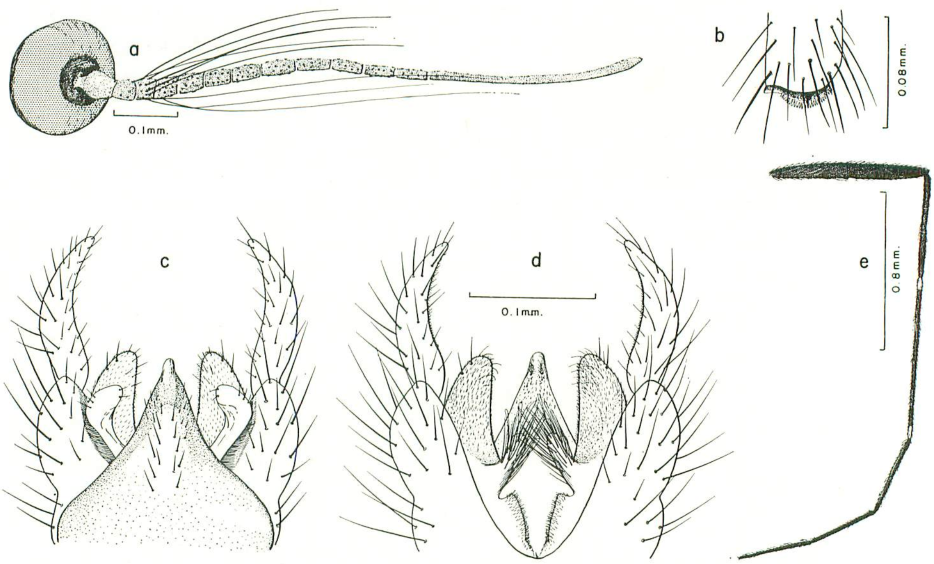

Figure 30—*Calopsectra* (*Micropsectra*) *lacteiclavus* (Grimshaw): **a,** antenna of male; **b,** apex of hind tibia; **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view; **e,** front leg.

Calopsectra lacteiclavus latifasciata, new subspecies.

This may represent a distinct species from *lacteiclavus*. It is readily differentiated by the entirely white basitarsi. On the specimen at hand, however, I find no reliable structural differences by which it can be separated, and at least until more material can be studied it is perhaps best to consider this as a subspecies. The genitalia and other details appear to be identical, or nearly so, with those of the typical species; the genital characters may differ slightly and the ventral lobe of the accessory appendages is slightly smaller and not as elongated as in typical *lacteiclavus*.

Holotype male: Nauhi Gulch, Hawaii, 5,000 ft., over stream; Oct. 2, 1931; no collector given. This had been determined as *Tanytarsus* sp. new? by F. W. Edwards, 1932. The type is in the B. P. Bishop Museum.

Genus **CHIRONOMUS** Meigen

Tendipes Meigen, 1800, N. Class. Mouches à deux ailes, 17. Rejected name.

Chironomus Meigen, 1803, Mag. f. Insecktenk. (Illiger) 2:260.

The Hawaiian species of *Chironomus* may be distinguished from other Chironominae since the wings are devoid of macrotrichia, the r–m crossvein is distinct and oblique in position, and a pair of well-developed tubercles is present in the middle of the front; also the antennae of the male are twelve-segmented with ten very short and one very long apical segment besides the short scape. The middle tibiae have one spine on each comb. The apex of front tibia is without a distinct spur on inner side but has a low rounded scale which is not distinctly projecting. The pronotum is complete and has a weak median notch in all our species. All our species fit in the subgenus *Chironomus* because the inferior appendages of the male genitalia are setulose and are much larger than the superior appendages; the latter are bare and are not abruptly enlarged at bases (fig. 31f).

The larger, more common species of Chironominae belong in this genus.

The larvae are slender and worm-like, with a blood-red body and a yellowish brown head in most species. For description refer to Johannsen (1937a:18–19).

Type of genus: *Tipula plumosa* Linnaeus.

Key to Known Species of Chironomus Meigen in Hawaii

1. Male antennae densely plumose. Head all yellow to rufous (including frontal tubercles). Wings hyaline..............2
   Male antennae very sparsely plumed. Head (including frontal tubercles) entirely black. Wings gray fumose. Male genitalia as in figure 33d.......**pauciplumatus n. sp.**

2. A narrow, brown, preapical band present on each femur. The apices of tibiae and tarsi narrowly brown to black. Ninth tergum of male without a keel. Anal point slender, not capitate (fig. 32e).................**hawaiiensis** Grimshaw.
   Legs not banded. Ninth tergum with a strong keel. Anal point short and capitate (fig. 31f)........**esakii** Tokunaga.

Chironomus (Chironomus) esakii Tokunaga (figs. 31a–g).

Chironomus esakii Tokunaga, 1940, Phil. Jour. Sci. 71(2):221.
Chironomus sp. Williams, 1945, Proc. Haw. Ent. Soc. 12:228.
Chironomus insolens Johannsen, 1946, Insects of Guam 2, B. P. Bishop Mus. Bul. 189:192. **New synonym.**
Tendipes sp. Wirth, 1946, Proc. Haw. Ent. Soc. 12:491; 1947, Proc. Haw. Ent. Soc. 13:9.

At my request Dr. M. Tokunaga, Kyoto, Japan, compared specimens from Guam with his *esakii* and confirmed the synonymy of *insolens* Johannsen. I have

also studied the type male of *C. insolens* Johannsen (Piti, Guam, 5–23–36, O. H. Swezey) kindly loaned to me from the Cornell University collection by Dr. Henry Dietrich.

Oahu, Hawaii, and Molokai. Rather common in the lowlands.

Immigrant. Marianna Islands, Saipan, and Guam (Type locality: Charanka, Saipan). Type in the Entomological Laboratory, Kyushu Imperial University, Japan.

This species has been recorded in our literature as the "plain-legged" *Chironomus*. It superficially resembles *C. hawaiiensis* Grimshaw but the legs are unbanded (lack the preapical femoral banding), the r–m crossvein is not distinctly infus-

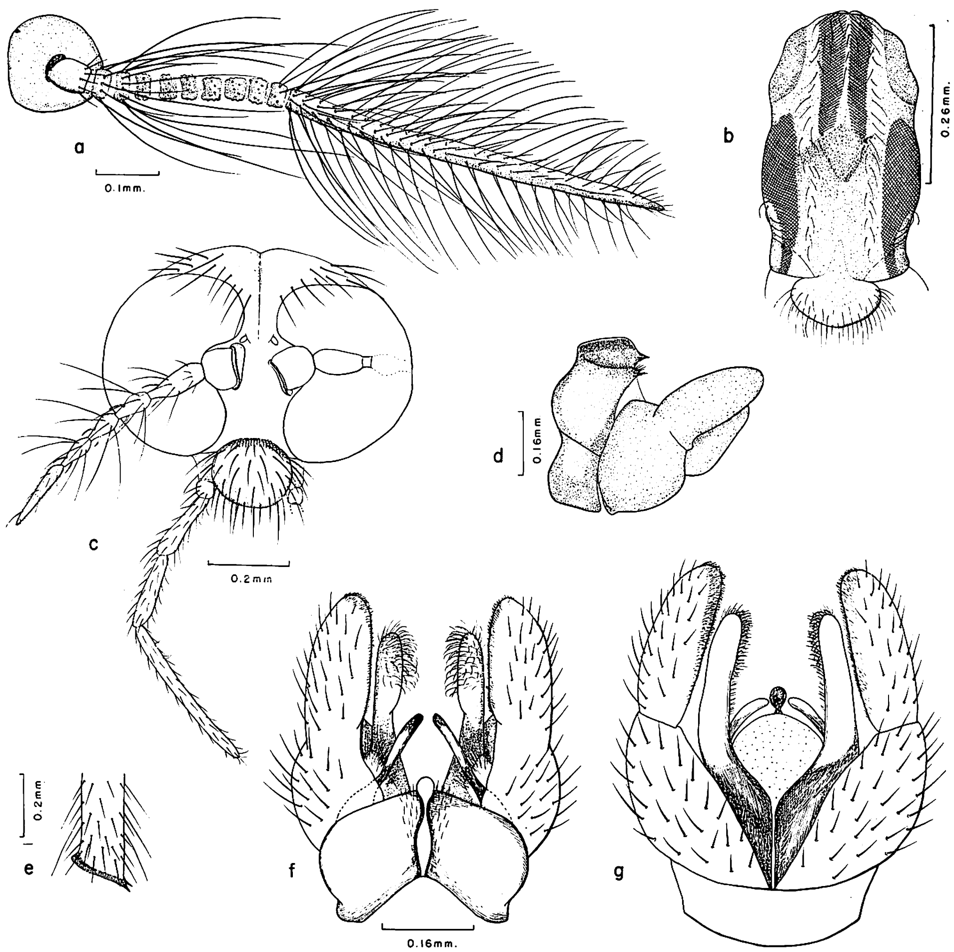

Figure 31—*Chironomus esakii* Tokunaga: **a,** male antenna; **b,** mesonotum, dorsal view; **c,** head of female; **d,** male genitalia, lateral view; **e,** apex of hind tibia; **f,** male genitalia, dorsal view; **g,** male genitalia, ventral view.

cated, the fork of cubitus is distinctly beyond the level of the r–m crossvein, and the male genitalia are very different (refer to figures 31f and 32e). It also closely resembles *C. samoensis* Edwards, but that species has the anal point (projection of 9th tergum of male) moderately long, not capitate at apex, and extending beyond the apices of the inferior appendages much as in *C. hawaiiensis* (fig. 32e).

Head (fig. 31c), thorax, and legs largely yellow; mesonotum with four brownish yellow to brown vittae; the median pair narrowly separated and extending only half the length of the mesonotum from the anterior margin (fig. 31b). Antennae of male densely plumose, segments proportioned as in figure 31a. The pronotum is complete and has a small notch in the middle. The wings are hyaline with no distinct fuscous markings; the fork of the cubital vein is distinctly beyond the r–m crossvein. The radial veins are setulose except for R_{2+3} and extreme base of R_{4+5}. The abdomen is predominantly brown with pale pile. The apices of the terga are narrowly yellow. The apex of the front tibia is developed into the usual broadly rounded scale-like development on the inner surface. The middle and hind tibiae each have a small spine developed on each comb; these spines are symmetrical (fig. 31e). The ninth tergum of the male has a strong dorsal keel which terminates posteriorly in a short, capitate anal point (fig. 31f). The superior appendages are entirely bare, slender, slightly curved, and blunt at apices. The dististyli are thick and blunt and the inferior appendages are elongate, rather slender, and extend almost to apices of dististyli (fig. 31g).

Length: body, 3.8–4.4 mm.; wings, 3.0–3.4 mm.

Chironomus hawaiiensis Grimshaw (figs. 32a–f).

Chironomus hawaiiensis Grimshaw, 1901, Fauna Hawaiiensis 3:4.

Endemic? Common in the lowlands on all the main Islands. (Type locality: Waialua, Koolau Range, Oahu.)

Six cotypes in British Museum (Natural History).

Differentiated from other Hawaiian *Chironomus* by the pale coloration and dull greenish to pale brownish yellow body; the densely plumose antennae of male; the pale yellow legs with a narrow band of brown just before the apex of each femur; the narrow ring of brown around the apex of each tibia; and by male genital characters (fig. 32e). The wings are hyaline. The head, including frontal tubercles, is entirely pale. Thorax not marked with black; the mesonotum has a brown vitta on each side extending from the posterior margin two-thirds the distance to the humeri, also a broad median brown vitta extends from anterior margin half the length of the mesonotum; the median vitta is bisected by a very narrow yellow line which extends down the middle (fig. 32d). The scutellum, median area in front of scutellum, and the shoulders are yellow covered with gray pollen. The wings are hyaline, the m crossvein is dark brown. The radial veins are setulose except for R_2 and extreme base of R_{4+5}. The fork of cubitus is situated about opposite the r–m crossvein (fig. 32a). Abdomen usually greenish in the living specimens turning brown after death, with yellow to yellow-gray apices on all of the terga. Male genitalia are as in figures 32e and f. The dististyli are slightly

swollen at their bases and rather slender apically. An elongate, slender anal point is present, and the superior appendages are slender and pointed.

Specimens have been studied which show considerable malformation of the palpi (fig. 32b). Some individuals, taken in a series of typical *hawaiiensis* from Ewa, Oahu, and from Hawaii National Park, Kilauea, Hawaii, have the palpi reduced to three segments, with a swelling, or enlargement at the middle of the apical portion. The amount of swelling varies greatly in different specimens—in some it is very large and others show just a slight swelling. Some specimens may have an enlargement on one palpus but not on the other and some have three rather shortened segments in one palpus and four normal segments in the other.

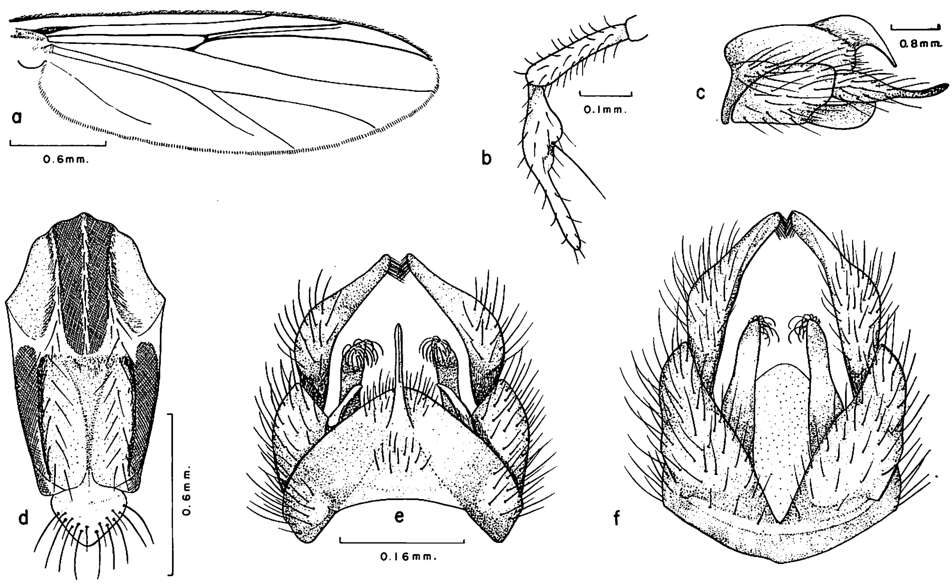

Figure 32—*Chironomus hawaiiensis* Grimshaw: **a,** wing; **b,** malformed palp; **c,** male genitalia, lateral view; **d,** mesonotum, dorsal view; **e,** male genitalia, dorsal view; **f,** male genitalia, ventral view.

Length: body, 4.0–5.0 mm.; wings, 3.0–3.5 mm.

This is the most common lowland species of chironomid. It is often attracted to lights in large numbers. It breeds in all types of fresh water habitats except rapidly moving mountain streams. The larvae are bright blood-red in color and are commonly found in reservoirs, ponds, ditches, taro patches, rice fields, etc., including fish bowls which contain surface feeding fish. They are often confused with mosquitoes by the layman. Williams (1944:155–158) has given an excellent account of the life history and habits of this species, including figures of the immature stages. This species is one of the favorite foods of dragon flies in Hawaii (Warren, 1915:73).

Chironomus pauciplumatus, new species (figs. 33a–d).
Chironomus sp. Williams, 1944, Proc. Haw. Ent. Soc. 12:158.
Tendipes (*Chironomus*) sp. Wirth, 1947, Proc. Haw. Ent. Soc. 13:26.

This species is distinguished from other Hawaiian *Chironomus* by the very sparsely plumose antennae of the male; the all-black head, including the frontal tubercles; the gray fumose wings; the lack of setae on most of vein R_{4+5}; and by the male genital characters as discussed and figured below.

Wirth (1947a:26) says, a female specimen from light trap at Hawaii National Park is apparently the same as that reported by Williams (1944:158) from high elevations on Molokai. . . . The color is dark brownish gray throughout including the wings. The mesonotum is narrower and more highly arched than in *T. hawaiiensis* (Grimshaw). I do not see distinctive differences in the width and height of the mesonotum in the specimens I have studied. Williams (1944:158, fig. 18) figures the caudal end of the larva which he found breeding among finely rooted grass in the water at the 3,000-foot elevation. The larvae differ from *hawaiiensis* by lacking the ventral gills which are so conspicuous on the eighth ventral segment of that species.

MALE. *Head:* Occiput, clypeus, and frontal tubercles brown to black; palpi dark brown; antennae chiefly brown; the basal segments are yellow tinged and are longer than wide (fig. 33a). The twelfth antennal segment is about one-third longer than the remainder of the flagellum. The entire antenna is very sparsely plumose, the apical segment contains approximately 30 long hairs, the apical third to fourth of the segment contains no long setae but is rather densely covered with short, pale pile (fig. 33b). *Thorax:* Predominantly yellow with yellow-brown markings on the mesonotum, rather similar to those of *hawaiiensis*, but with a narrow line of black extending from the wing base along each lateral margin of the mesonotum, with an incomplete narrow black line extending across the middle of pleura and with the lateral margins and median portion of pronotum black. Halteres yellow, faintly tinged with brown on their apices. *Legs:* Not banded. The coxae and trochanters are yellow, faintly tinged with brown. The remainder of the legs are brown with a slight yellow tinge in the ground color. The front metatarsi are about one-half longer than tibiae. The middle and hind tibiae each have a short spine developed on each of the combs. *Wings:* Distinctly gray fumose. Vein R_{4+5} setulose only at its base. Vein R_1 ends opposite a point about four-fifths the distance between the tips of Cu_2 and Cu_1. R_{4+5} is curved downward slightly, its apex reaches near the tip of the wing. The costa ends at the apex of R_{4+5}. *Abdomen:* Almost entirely dark brown to black, the very narrow apices of the terga are yellow. The genitalia are brown to black. The anal point is very short and blunt. The ninth tergum has a small bump (lobe) on each side of the posterior margin. The superior appendages are sharp-pointed on their inner side. The inferior appendages are long and slender and the dististyli are concave on their inner surfaces (fig. 33d). The dististyli are one-half longer than basistyli, almost parallel sided.

Length: body, 4.0 mm.; wings, 3.0 mm.

FEMALE. Similar to the male except for genital characters and that the

mesonotum is more unicolorous and the yellow markings not so well defined. Also, a narrow black streak extends down each side of the frontomedian gibbosity of the mesonotum. The flagellum of the antenna is 6-segmented; the apical segment is devoid of long setae except for two which arise near the apex and it is equal or slightly longer than the combined length of the two preceding segments (fig. 33c).

Holotype male, allotype female, and four paratypes (two males and two females): from spring near Wailau Pass, 2,800 feet, Molokai; Dec., 1937 (F. X. Williams). Also, one paratype female: Puu Kolekole, Molokai; July, 1953 (D. E. Hardy). One female specimen is at hand from Kilauea, Hawaii, Hawaii National Park, Nov., 1946, at light (C. J. Davis), which seems to belong here. The mesonotum and femora are discolored with brown, however; the antennae are broken. It is not being designated as a paratype and is being returned to the U. S. National Museum collection marked with a query.

Type and allotype in the collection of the Hawaiian Sugar Planters' Association. The paratypes are being distributed among the following collections: B. P. Bishop Museum, U. S. National Museum, and the University of Hawaii.

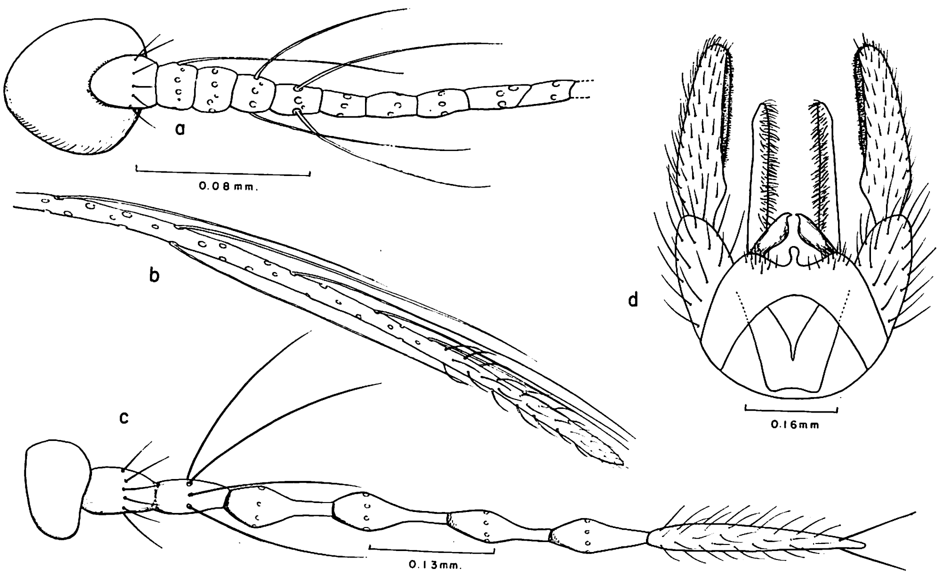

Figure 33—*Chironomus pauciplumatus* n.sp.: **a,** antenna of male, excluding the apical segment; **b,** apical segment of male antenna; **c,** female antenna; **d,** male genitalia, dorsal view.

Genus **POLYPEDILUM** Kieffer

Polypedilum Kieffer, 1913, Bull. Soc. Hist. Nat. Metz 28:15.
Pentapelma Kieffer, 1921, Ann. Soc. Sci. Bruxelles 41:98.
Propedilum Lenz, 1937, Arch. Hydrobiol. Suppl. 15:13.

This genus fits in the tribe Chironomini by having the wings bare of micro-

trichia, the squama with a marginal fringe, and the r–m crossvein distinctly oblique in position. It is differentiated from *Chironomus* by having fourteen segments in the antenna of the male; also, rather than having one spine on each comb as in *Chironomus*, there is a spine on the inner comb of middle tibia and outer comb of hind tibia and the other combs are unarmed. The front tibiae terminate in a pointed scale which ends in a conspicuous spine (fig. 34b) and the pulvilli are bifid (visible only at high magnifications). Our species is readily distinguished from other Chironomini in Hawaii by its spotted wings (fig. 34a).

Edwards (1929:401) and Coe (1950:192) treat this as a subgenus of *Chironomus*. Townes (1945:36; 1952:48), also Goetghebuer (1937:56), treat it as a distinct genus.

Apparently just one species occurs in Hawaii. It fits in the subgenus *Polypedilum* by having the wing membrane bare, R_{2+3} lying very close to R_1, and the superior appendages and anal point slender, each superior appendage with but a single bristle beyond base.

According to Johannsen (1937a:30) the larvae "are usually blood-red, in color, with black eye spots which in most cases are contiguous." Refer to Baini Prashed (1918) for a study of the anatomy of the larva of an Indian species.

Type of genus: *Polypedilum marginatum* Kieffer (=*nubeculosum* Meigen).

Polypedilum novemmaculatum, new species (figs. 34a–g).

Tendipes sp. "spotted winged", Wirth, 1946, Proc. Haw. Ent. Soc. 12:491.

Polypedilum sp., Wirth, 1947, Proc. Haw. Ent. Soc. 13:9.

In Townes' monograph of the Nearctic species of *Polypedilum* (1945:47), this runs to *P. laetum* (Meigen). The specimens in the U. S. National Museum collection had been determined as "*P. laetum?*" by Dr. Wirth. The wing maculations of the species at hand are quite different, however, from *laetum*, and the superior appendages of the genitalia are straight, not curved. Townes (p. 50–51) says specimens of *P. laetum* show considerable variation in the wing spotting, but the variations from the normal which he noted included the presence on some specimens of a small spot below the tip of Cu_2 and a narrow longitudinal spot in cell R_5 just above and not touching vein M. This faint secondary spot in R_5 is apparently more consistently present in European specimens. The presence of three spots in cell R_5 and three in cell M will differentiate *novemmaculatum* from *laetum*. If this condition represents a variation, a good many of the species based upon wing maculations would have to fall as synonyms. In Goetghebuer (1937:58), *novemmaculatum* runs directly to *P. anuke* Kieffer, from Egypt, but that species has three spots in cell Cu and only one spot in cell A. The species at hand has one spot in cell Cu and two in cell A. Also, the genitalia of *anuke* is quite different. Goetghebuer's figure shows that the anal point is evenly tapered, not long and slender, and the superior appendages are strongly curved. The wing markings most closely resemble those of *P. lene* Becker (Goetghebuer, 1937, fig. 35), except that there is no evidence of a mark at apex of Cu_1 in *novemmaculatum* and two

spots are present in the anal cell. Also, *lene* fits in the group of species which have all white halteres.

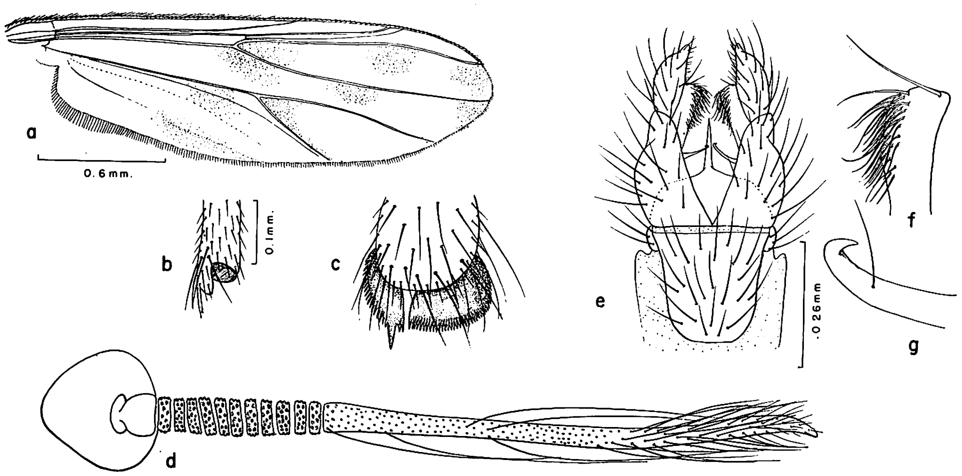

Figure 34—*Polypedilum novemmaculatum* n.sp.: **a,** wing; **b,** apex of front tibia; **c,** apex of middle tibia; **d,** male antenna; **e,** male genitalia, ventral view; **f,** apex of inferior appendage; **g,** apex of superior appendage.

MALE. *Head:* Brownish, tinged with yellow, including the appendages. The head has about a dozen long yellow bristles on each side of the eyes. Also the clypeus is rather densely covered with yellow setae. Antennae densely plumose, the length of the plumes gradually decreasing toward the apex. The apical segment is very elongate, being over two times longer than the remainder of antenna (fig. 34d). The eyes are narrowed to about five rows of facets on each side above. The apical segment of the palpus is one-half longer than the penultimate segment. *Thorax:* Brown, tinged with yellow in the ground color. The ground color of the anterior portion is clear yellow. The entire thorax is rather thickly gray pollinose. The pronotum is entire, with no median notch; it is moderately developed, plainly visible from above. All of the thoracic vestiture is yellow. Dorsocentral hairs are rather numerous on the posterior half of the mesonotum and the scutellum has a row of short hairs around its margin. The halteres are yellow with the extreme apices brown to black. *Legs:* Yellow, brownish on coxae. Front tibiae each with a thumb-like projection at the apices (fig. 34b); others with a short comb and a strong apical spur (fig. 34c). The proportions of tibiae to the basitarsi are as follows: front legs 100–125, middle legs 105–67, hind legs 123–93. *Wings:* Slightly milky, the veins yellow; those along the anterior margin are faintly tinged with brown, the posterior veins are pale. The subcostal vein is faint and ends about opposite the apex of vein Cu_2. Vein R_1 ends about opposite a point two-thirds the distance between the apices of veins Cu_2 and Cu_1. Vein R_{2+3} lies very close to R_1 and is difficult to discern. The costa ends at the tip of R_{4+5}. The r–m crossvein is

about two times longer than the basal section of R_{4+5}. The fork of cubitus lies just beyond the crossvein. Three gray spots are present in cell R_5, one rather large spot filling the basal portion of the cell, a round spot at about the middle of the cell, and another near the upper apex. Three spots are present in cell M, one situated just below the basal spot in R_5 and lying close to vein M, another rather elongate spot in the median portion of the cell, and another rather transverse spot near the apex. Cell Cu has a large gray spot at its base, this mark extending along vein Cu_2 approximately to the wing apex. Two rather indistinct spots are also situated in the anal cell (fig. 34a). *Abdomen* and *genitalia:* Entirely dark brown to black with yellow vestiture. Anal point elongate, very slender; equal or slightly longer than the superior appendages. Superior appendages straight, slightly pointed at apices, and each with a single strong bristle above near apical two-thirds (fig. 34g). Inferior appendages thickly covered with short, recurved bristles on ventral surfaces (fig. 34f). The dististyli rather short and thick, about two and one-half times longer than wide, slightly tapered at apices (fig. 34e).

Length: body, 4.0 mm.; wings, 2.5 mm.

FEMALE. Fitting the description of the male except for sexual characters. The wing maculations are more distinct, however; the antennae are 6-segmented and the apical segment is slender, approximately as long as the two preceding segments. Segments 2 to 5 are attenuated on their apical portions, the necks about one-third as long as the remainder of the segment.

Holotype male, allotype female, and 14 paratypes (4 females, 10 males): Ewa, Oahu, Marine Corps Air Station, at light, Dec. 8, 1945 (W. W. Wirth). Some of the paratypes taken Nov., 1945, and March, 1946 (W. W. Wirth); the latter taken by sweeping sedges near pond and reared from pond. Fourteen topotypic specimens, layered in a pill box, are also on hand.

The type, allotype, and a series of paratypes in the U. S. National Museum. The remainder of the paratypes are being deposited in the following collections: B. P. Bishop Museum, British Museum (Natural History); and the University of Hawaii. The layered specimens have also been returned to the U. S. National Museum.

This is the "spotted winged" *Polypedilum* sp. reported by Wirth from ponds at Ewa (Wirth, 1947:9), earlier reported by Wirth (1946:491) as a "spotted winged *Tendipes* from the Ewa light trap."

Subfamily TANYPODINAE Skuse

Tanypina Skuse, 1889, Proc. Linn. Soc. N. S. Wales (2)4:222.
Tanypodinae F. Lynch Arribalzaga, 1893, Bol. de la Acad. Nat. de Ciencias en Cordoba, p. 220.
Tanypinae Kieffer, 1906, Ann. Soc. Sci. Bruxelles 30:315.
Tanypodini Handlirsch, 1925, in Schröder's, Handbuch der Ent. 3:970.
Pelopiinae Goetghebuer, 1936, in Lindner's, Die Fliegen der Pal. Reg. 13b:3.

Members of this subfamily are characterized by having the m–cu crossvein

present (fig. 35a). This is interpreted as the base of vein M_{3+4} by Freeman (1956:19).

Wirth and Stone (1956:412–413) say the larvae of Tanypodinae (as Pelopiinae) are predaceous, feeding largely upon other chironomid larvae and are "often found in the cases made by their prey, although they build none themselves. They are especially abundant in permanent streams, ponds and lakes." They are readily distinguished from other subfamilies of Chironomidae by their retractile antennae and their long stilt-like prolegs. Refer to Wirth and Stone and to Johannsen (1937:5) for descriptions and figures of the immature stages.

Just one genus and species (*Pentaneura planensis* Johannsen) is known from Hawaii.

Genus **PENTANEURA** Philippi

Pentaneura Philippi, 1865, Verh. Zool.-Bot. Ges. Wien 15:629.

For synonymy refer to Freeman (1955:20).

This is the only representative of the subfamily Tanypodinae known to occur in Hawaii. The group is easily recognized by the presence of the m–cu crossvein. The wings are densely haired as in *Calopsectra* and *Metriocnemus* and the venation is difficult to interpret unless the wings are denuded and mounted on a slide. Vein R_{2+3} is apparently present but is often difficult to find because of the close approximations of veins R_1 and R_{4+5}. The body is also thickly covered with long hair and the pronotum is more reduced than in other genera of this subfamily.

According to Johannsen (1937a:8), *Pentaneura* larvae are slender and cylindrical and the thorax is slightly enlarged. The body segments have just a few scattered bristles. The anterior prolegs are elongate and both pairs of anal gills are situated close to the anal opening. The body is usually yellowish or white, mottled with brown. For more complete descriptive details and figures see Johannsen.

Type of genus: *Pentaneura grisea* Philippi [=*P. cinerea* (Philippi)].

Pentaneura planensis Johannsen (figs. 35a–d).

Pentaneura planensis Johannsen, 1946, Jour. N. Y. Ent. Soc. 54:284.
Pentaneura sp., Wirth, 1947, Proc. Haw. Ent. Soc. 13:8.

Oahu. (This has been taken only at Ewa, Waipio, and Kalihi.)

Immigrant. Previously known only from the holotype male from Texas.

Type in the U. S. National Museum.

The specimens from Oahu fit Johannsen's description of *planensis* in all details. At my request Dr. W. W. Wirth compared specimens with the type in the U. S. National Museum and reported that the genitalia seemed to be identical and that the specimens showed but slight differences in body coloration. He said "The type of *planensis* has faint but distinct mesonotal vittae and dark abdominal bands which do not show up nearly so well in your material." I believe it best to consider our species *planensis*, at least until the species has been studied more thoroughly. In Coe (1950:130) this runs to group E (subgenus *Pentaneura*) by

having vein R_{2+3} absent or very faint and R_{4+5} ending beyond tip of Cu_1. The costa extends slightly beyond the tip of R_{4+5}, fitting somewhat the characteristics of the genus *Anatopynia* Johannsen; but the female antenna contains but 12 segments, not 15. In Goetghebuer (1936:4) it runs to *Ablabesmyia* Johannsen (synonym of *Pentaneura Philippi* according to Johannsen, 1952:5) but will not fit any of the included species.

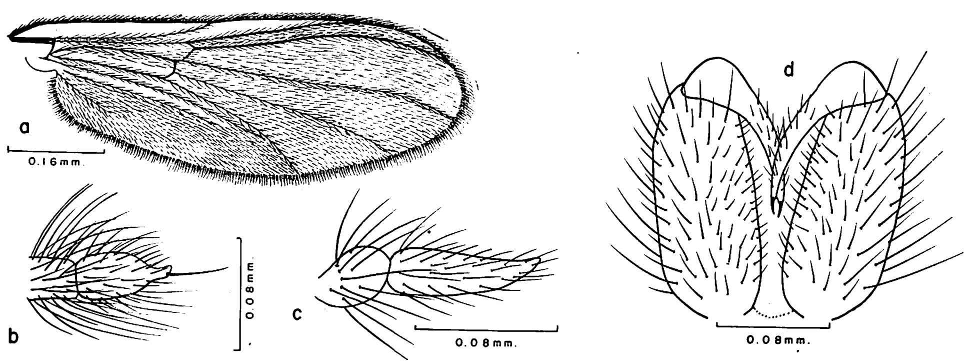

Figure 35—*Pentaneura planensis* Johannsen: **a**, wing; **b**, apex of male antenna; **c**, apex of female antenna; **d**, male genitalia, ventral view.

MALE: An entirely yellow species with no dark markings. Body and legs covered with rather long yellow hairs. Head entirely yellow, including the appendages, but excepting the compound eyes. The narrowed portion of the eyes across the sides of the front are equal to about three or four eye facets in width. The eyes are separated by less than the width of one scape. A row of ten setae are situated behind eyes on each side of upper front and vertex. The basal antennal segments are very large, confluent in the middle. Eyes bare. Antennae very densely plumose, apparently 15-segmented; the segments are poorly defined, difficult to interpret; the apical portion is very short (fig. 35b); the penultimate segment is approximately 1.35 times longer than the remainder of the flagellum. Legs short. Tibial combs are developed at apices of all tibiae and occupy about one-third of the circumference; no apparent spines arise from the combs. The tibiae are about one-fourth to one-fifth longer than the basitarsi. The proportions of the tibiae to the basitarsi are as follows: front legs 115–85; middle legs 125–100; hind legs 95–70. The front tarsi are not conspicuously long-haired (bearded). Pulvilli lacking, empodium short and extending less than half the length of claws. Each claw with a short tooth at base. Thorax entirely yellow, mesonotum marked with three darker yellow (faintly brownish tinged, especially in the female) markings set off by the whitish yellow coloration of shoulders extending back along each dorsocentral line. Pronotum divided, not continuous across middle as seen from dorsal view. Wings very densely covered with macrotrichia. Squamae fringed with long hairs. The subcostal vein ends just beyond the r–m crossvein. R_1 ends at a point

about opposite one-half the distance between tips of Cu_1 and Cu_2. Vein R_{2+3} is very faint or lacking. The fork of cubitus is just behind the m–cu crossvein and the basal part of Cu_1 is oblique (fig. 35a). Abdomen elongate, slender, entirely yellow except for a slight tinge of brownish on the terga. The diststyli are about two-thirds as long as the basistyli and are tapered to slender, sharp points (fig. 35d).

Length: body, 2.2 mm.; wings, 1.7 mm.

FEMALE. The narrowed portion of each compound eye is about five facets wide and the eyes are separated by a distance slightly more than the width of the scape. The antennae are 12-segmented; the last segment is pointed at apex and nearly two times longer than penultimate segment (fig. 35c). The palpi are very elongate, almost as long as antennae; the last segment is slightly longer than the last four antennal segments. The cerci are a little higher than long. The spermathecae are small, faintly sclerotized, with short straight necks.

Length: body and wings, 1.5–1.7 mm.

According to Dr. Wirth this species breeds in shallow, marshy, algae-choked ponds in the Ewa and Kahuku areas of Oahu.

Subfamily CORYNONEURINAE Goetghebuer

Corynoneurinae Goetghebuer, 1932, Fauna de France 23:131; 1939, in Lindner's, Die Fliegen der Pal. Reg. 13f:1. Freeman, 1956, Bul. Brit. Mus. (Nat. Hist.) Ent. 4(7):360.

I am following Goetghebuer and Freeman in treating this group as a subfamily because of the very distinctive wing venation. Freeman (1956) defined the subfamily as follows: "R_1 and R_{4+5} entirely fused with one another and almost entirely fused with the thickened costa to form a 'clavus,' which extends less than half the wing length in the male and not more than two-thirds of the wing length in the female; a false vein runs from r–m below the clavus and then close to the wing margin almost as far as the wing tip; wing membrane without macrotrichia or microtrichia, anal lobe of wing usually absent; squama bare, fourth tarsal segment shorter than the fifth and often more or less heart-shaped; male antenna with 10–13 segments; very small species, wing length less than 2 mm." Freeman also indicated that the male genitalia are distinctively developed in members of this subfamily. "The internal struts are larger than usual and exhibit specific differences throughout the subfamily; their greatest development is in *Corynoneura*. Here the transverse struts are lengthened (Text—fig. 16a), articulate basally with the other pair, and form a pair of curved 'parameres.' "

Two genera are recognized in this subfamily by Freeman: *Thienemanniella* Kieffer and *Corynoneura* Winnertz. Only the latter genus occurs in Hawaii.

According to Johannsen (1937a:37) the larvae of this group (*Corynoneura sens. lat.*) are differentiated by their small size; by having the "antennae at least half as long as head, in some cases longer than head, second segment slightly bent and darkened; posterior prolegs with a basal ventral spur;" rather than having the

antennae usually much shorter, the second segment not bent, and the prolegs lacking a spur.

Genus **CORYNONEURA** Winnertz

Corynoneura Winnertz, 1846, Stett. Ent. Zeitung. 7(1):12.

A very distinctive genus characterized by having the radial veins fused with the costa and ending near the middle of the wing (fig. 36a) and also by having a false vein running close to the anterior margin of the wing. Our species fits in the genus *Corynoneura* by having the apices of the hind tibiae distinctly swollen and each with a conspicuous apical projection on the inner side (fig. 36d). The eyes are bare and, according to previous descriptions, terga 2 to 5 of the male abdomen each with a single mid-dorsal bristly hair.

These are very minute, active flies. According to Seguy (1951:610) at least one species (*C. celeripes* Winnertz) develops parthenogenetically. Johannsen (1937a:40) says the larvae of *Corynoneura* are very slender and tapered at both ends. "The elongate four-segmented antennae are at least one-third longer than the head." For further descriptive details and figure, see Johannsen. Just one species is known from Hawaii.

Type of genus: *Corynoneura scutellata* Winnertz.

Corynoneura sp.? (figs. 36a–d).

Several females of a *Corynoneura* have been collected, but it is impossible to place them as to species until the male has been studied. The specimens fit the description of *C. seychellensis* Kieffer (1912:363). It may be slightly larger, however; Kieffer gave the length as 0.6 mm., but the specimens at hand measure 0.75–0.9 mm. In Tokunaga's revision of the Japanese species (1936:33), it (the female) would fit the descriptions of several species but seems to agree best with that of *C. cuspis* Tokunaga.

A tiny, nearly all-yellow species characterized by having three broad brown vittae on mesonotum and by the peculiar wing venation (fig. 36a).

This is the species recorded as *Corynoneura* species by Wirth (1947a:21). Wirth had one specimen taken on rank growth of nasturtium in a boggy area at Kokee, Kauai. He said, "It is of minute size, the wing venation quite characteristic with a stigma on the costal margin."

FEMALE. *Head:* The front is very broad, about four times wider than the scape of one antenna. The front is bare and there are no apparent setae on either side on the specimens at hand. The eyes are oval, the inner margin nearly straight. The clypeus contains just a few long setae near the upper margin. The palpi are short, the apical segment about one-third longer than the penultimate. The antennae have but six segments (fig. 36b). The apical segment is about equal to the two preceding segments and the apical half is densely pubescent. *Thorax:* Mesonotum with three broad brown vittae, the median one extending over the anterior half and one on each side extending down posterior three-fifths of the mesonotum

(fig. 36c). Metanotum bordered with brown. Base of scutellum tinged with brown. Scutellum with two small submedian setae near apex. Halteres yellow. *Legs:* Front tibiae with two short inconspicuous spurs at apex; middle tibiae each with but a single short spur; hind tibiae enlarged at apex and each with a strong projection containing a comb of about a dozen bristles and with a spine at apex (fig. 36d). The front femora are somewhat enlarged, the other femora more slender. The proportions of the tibiae to the basitarsi are as follows: Front legs 50–30, middle legs 58–35, hind legs 60 (including apical projection but not apical spine)–30. *Wings:* Venation greatly reduced, the radial veins and costa fused into a thickened area along anterior margin and extending slightly beyond middle of wing. Just a faint indication of the false vein (noted by Johannsen) is visible on the specimens at hand and there is no indication whatsoever of a median vein. The fork of cubitus is at about the apical fifth of the wing. Cu_1 is very short, extending just a short way beyond the fork before it evanesces. Cu_2 extends about two-thirds the distance to the wing margin. The anal veins are very faint. They apparently extend about two-thirds the length of the cubital vein (before the fork). *Abdomen:* Short and broad, chiefly yellow, the bases of the terga tinged with brown. The narrowed necks of the spermathecae are straight.

Length: body and wings, 0.75–0.9 mm.

MALE. Unknown.

This is very probably an immigrant. To date three females are at hand taken in a light trap at Ewa, Oahu, June–March, 1955–1957; also one female from Kokee, Kauai, Sept. 6, 1946, "on nasturtiums in bog," 4,000 ft. (W. W. Wirth).

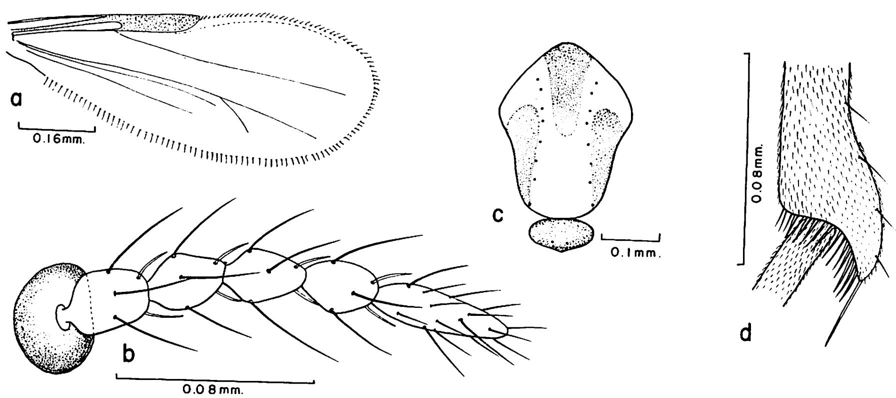

Figure 36—*Corynoneura* sp.♀: **a,** wing; **b,** antenna; **c,** mesonotum; **d,** apex of hind tibia.

Subfamily ORTHOCLADIINAE Kieffer

Chironominae Kieffer, 1906, in part, Gen. Ins. 42:7.
Orthocladiariae Kieffer, 1916, Ann. Mus. Nat. Hung. 14:102.

Orthocladiinae Dorier, 1933, Travaux du Lab. d'Hydrob. et de Pisciculture de Grenoble 25:191.
Orthocladinae Goetghebuer, 1936, in Lindner's, Die Fliegen der Pal. Reg. 13b:3.
Hydrobaeninae Townes, 1945, Amer. Midland Nat. 34:12.

The name for this subfamily has been very controversial. Following Johannsen (1937a; 1952:22) and Townes (1945), who in turn followed Edwards (1940:154), the American workers have for the most part considered *Orthocladius* van der Wulp as a synonym of *Hydrobaenus* Fries or of *Spaniotoma* Philippi and have used the subfamily name Hydrobaeninae to replace Orthocladiinae. Coe (1950:148) also treated *Orthocladius* as a synonym of *Hydrobaenus* but used *Orthocladius* as a subgenus and used the subfamily name Orthocladiinae. The most recent works on the group by Freeman (1956:293) and Brundin (1956:19) state that Edwards was probably wrong in synonymizing *Orthocladius* with *Hydrobaenus*, and both workers indicate that the latter is best regarded as an aberrant small genus of its own (based upon *Hydrobaenus lugubris* Fries, the only included species). Evidently Goetghebuer is also in agreement with this concept (from correspondence with Freeman) although, in his treatment of his tribe Orthocladiini under the subfamily Orthocladiinae (1942:30), *Hydrobaenus* is not included. Later (1950:207), Goetghebuer discussed *Hydrobaenus* as a doubtful genus ("Zweifelhafte Gattung") containing the species *lugubris* Fries and *glacialis* Lundström. Edwards (1929:326) and also Johannsen (1937:55) treated *Orthocladius* as a synonym of *Spaniotoma* Philippi, and many of the workers have tentatively accepted this. Goetghebuer (1950:149) treats it as a questionable synonym of *Psectrocladius* Kieffer; this was taken directly from Edwards (1929:331). Freeman (1956:291–293) and Brundin (1956:18) indicate that it is not possible to recognize *Spaniotoma* and it must be considered as a *nomen dubium*.

There is also much controversy among the workers concerning the breakdown of the genera of Orthocladiinae and especially of the genus *Orthocladius sens. lat.* For the most part, the American workers have followed the more conservative classification based upon Edward's work and have used a few large genera for the bulk of the species, subdividing these into subgenera and using a few small genera for the more distinctive species. Goetghebuer, Freeman, and Brundin have split these groups (especially *Orthocladius sens. lat.*) rather finely, but apparently have ample justifications to back up their conclusions. Very few of the controversial issues are involved in treating the Hawaiian species and I have not had an opportunity to study enough materials to draw any conclusions as to which system is more nearly correct.

The Orthocladiinae have been rather thoroughly studied in Europe, but are very poorly known in the Western Hemisphere and over much of the world. The latest revisional study is that of Brundin (1956).

Members of this subfamily are set off in a group with the Clunioninae by having the front basitarsi shorter than the tibiae; the eyes reniform or round, not expanded across the front (fig. 37f); and the front tibiae with well-developed spurs as well as by other details. The Orthocladiinae differ from the Clunioninae by

having a well-defined horizontal suture present between the mesopleuron and sternopleuron (anepisternal suture) reaching almost to the front coxa. The pronotum is not divided into lateral lobes and the antennae of the male have 13–14 segments and are plumose. The wings are hyaline in all of our species; the postnotum has a distinct median keel and the genital characters and other details of the legs and body are very different; in most of the Hawaiian species a distinctive lobe is developed on the inner margin of each basistylus. *Orthocladius* (*Smittia*) *maculiventris* (Edwards) is an exception in the latter respect (fig. 41b).

The Orthocladiinae in Hawaii are apparently all terrestrial breeders (except for *Cricotopus*), while the Clunioninae breed in marine or fresh water habitats. The immatures of the Hawaiian Orthocladiinae which have been studied developed in humus, mosses, and similar habitats. According to Johannsen (1937a:4), the larvae of this subfamily differ from those of Chironominae by having the "Paralabial plates absent; mandibles without a longitudinal row of bristles (preapical mandibular comb) overhanging the teeth; maxillary palpus scarcely longer than broad (including Clunioninae)."

Three genera are known to occur in Hawaii: *Orthocladius* van der Wulp, *Metriocnemus* van der Wulp, and *Cricotopus* van der Wulp.

Genus **CRICOTOPUS** van der Wulp

Cricotopus van der Wulp, 1874, Tijdschr. v. Ent. 17:132.
Trichocladius Kieffer (in part), 1906, Mem. Soc. Sci. Bruxelles 30:356.
Isocladius Kieffer, 1909, Bul. Soc. Hist. Nat. Metz 26:44.
Eucricotopus Thienemann, 1933, Deutsch. Ent. Zeitschr. 1933:5.
Paratrichocladius Thienemann, 1942, Zool. Anz. 139:201. *Nec* Santos Abreu, 1918, Mem. Acad. Barcelona (3) 14:204.
Synonymy from Brundin (1956:109).

This genus is distinguished from other Orthocladiinae by having the eyes densely pubescent; the dorsocentral and scutellar hairs minute, decumbent and not arising from obvious punctures; humeral pits small; squamae with a complete fringe; and the male genitalia without an apical projection on the ninth tergum (anal point lacking). Just one species is known from Hawaii.

Apparently several species of *Cricotopus* mine the leaves of aquatic plants; see Tokunaga (1936:12), Berg (1950:85–91) and Hering (1951:206). Seguy (1951:609) says the eggs of some species are glued onto leaves and floating objects in the water. Several species are economic pests of rice in some areas (Risbec, 1951).

According to Johannsen (1937a:37,51), the larvae of *Cricotopus* are yellow, yellow-green, or blue-green and they are differentiated from related genera by having several transverse furrows, or wrinkles, on the convex side of each mandible rather than having this surface smooth or with but one or two furrows. For descriptive details and figures refer to Johannsen.

Type of genus: *Chironomus tibialis* Meigen, designated by Coquillett (1910: 528). Goetghebuer (1950:159) indicated *Chironomus silvestris* Fabricius as the

genotype (this should be spelled *sylvestris*). Brundin (1956:110) also indicated *sylvestris* as the type.

Cricotopus bicinctus (Meigen) (figs. 26, 37a–f).
Chironomus bicinctus Meigen, 1818, Syst. Beschr. 1:41.

For synonymy refer to Goetghebuer (1950:168) and to Tokunaga (1936:16).
Oahu and Kauai. Apparently a recent introduction, first discovered in large numbers in a light trap at Waipio, Oahu, September 8, 1955, by J. W. Beardsely (see Hardy, 1956b:15). Also collected along roadside at Kipapa Gulch, Sept. 9, 1955, by D. E. Hardy. It is now very common in the lowlands of Oahu and is probably on other islands.

Immigrant: Rather widespread over Europe; also recorded from Japan and the eastern United States.

The type is in the Muséum National d'Histoire Naturelle, Paris.

The species is readily distinguished from all other Hawaiian chironomids by the bright yellow bands on the abdomen. It is separated from other species of *Cricotopus* by having abdominal segments 1 and 4 entirely yellow and the remainder of the abdomen (except the white styli on genitalia) brown to black, the front tarsi entirely dark and the front tibiae broadly blackened at apices and narrowly so at bases; the pulvilli lacking; the costa slightly produced beyond the tip of R_{4+5}; and the male genitalia with a basal lobe on basistyli (fig. 37b).

MALE. Head with five short bristles on each side above eyes. The eyes are densely pubescent, concave on inner margin. The antennae are 14-segmented, the segments proportioned as in figure 37f. The last segment is longer than remainder of antenna, the proportions being 95 to 80 (including basal segment). Palpi as in figure 37f; proportions of last segment to penultimate is 33 to 20. Thorax predominantly dark brown to black; the pronotum entirely yellow and deeply notched in the middle. In the specimens at hand the mesonotum is broadly yellow on the anterior corners and a brownish yellow line extends down each dorsocentral area. The depressed region in front of the scutellum is also brownish yellow. The scutellum is brown, tinged with yellow. The metanotum is subshining black. The scutellum is bare except for about a dozen microscopic setae around margin, and only minute hairs are present on the mesonotum (in the dorsocentral rows). Halteres yellow. Femora predominantly brownish, somewhat darker at their apices. Front tibiae each with a broad whitish band extending from about the basal one-fifth to just beyond the middle of the segment. The middle and hind tibiae are predominantly pale. Wings hyaline, very faintly milky. The veins are slightly yellowed, not much darker than the membrane. The costa extends almost one-fifth the distance between the tips of R_{4+5} and M. Vein R_{2+3} ends approximately half way between R_1 and R_{4+5}. The r–m crossvein is three or more times longer than the base of R_{4+5}. The fork of cubitus is just slightly beyond the r–m crossvein. Vein Cu_2 extends to the wing margin. The first anal vein is straight and extends beyond the fork of Cu. The squama is fringed along the entire margin.

Color pattern of abdomen and structure of male genitalia as in figures 37b and c.
Length: body, 2.5–3.0 mm.; wings, 2.0 mm.

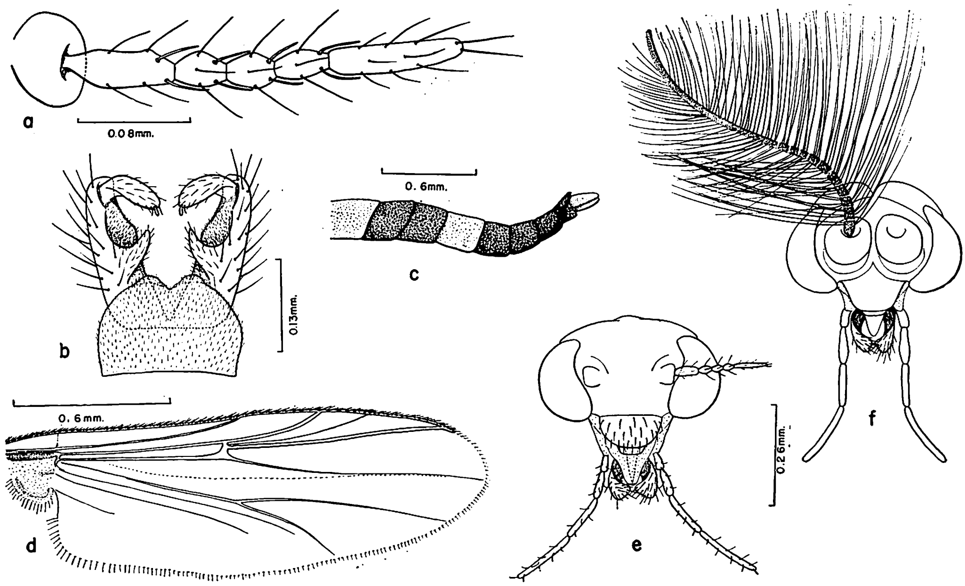

Figure 37—*Cricotopus bicinctus* (Meigen): **a,** female antenna; **b,** male genitalia, dorsal view; **c,** abdomen of male, lateral view; **d,** wing; **e,** head of female, front view; **f,** head of male, front view.

FEMALE. Paler in color than the male, the body is predominantly brownish yellow, not so distinctly marked with black. The antennae are six-segmented and shorter than the palpi (fig. 37e); the segments are not strongly attenuated apically, and the last segment is two and one-half times longer than the penultimate (fig. 37a). Spermathecae oval, with short straight necks.

For more complete description of the adult see Tokunaga (1936:16).

According to Johannsen (1937a:52), the larvae of this species are distinguished from other known, Nearctic *Cricotopus* by having the "basal antennal segment slender, four to five times as long as broad; brush of mandibles rather broad at base, the basal bristle-segments longer than the disc ones." Refer to Johannsen (p. 54) for more complete description.

Genus **ORTHOCLADIUS** van der Wulp

Orthocladius van der Wulp, 1874, Tijdschr. v. Ent. 17:132.

Spaniotoma subgenus *Orthocladius*, Groups D-F, Edwards, 1929, Trans. Ent. Soc. Lond. 77:344–350.

Orthocladius sens. str. and subgenus *Pseudorthocladius* Goetghebuer, 1932, Fauna de France 23:93.

Hydrobaenus Fries, Edwards, 1940, in part, Proc. Roy. Ent. Soc. Lond. (B) 9:154.
Pseudorthocladius Goetghebuer, Freeman, 1953, Proc. Roy. Ent. Soc. Lond. (B) 22:134.
Synonymy taken from Freeman (1956:330).
The following are synonyms listed by Brundin (1956:93):
Eudactylocladius Thienemann, 1935, Stettin. Ent. Zeitg. 96:206.
Euorthocladius Thienemann, 1935, Stettin. Ent. Zeitg. 96:201.
Rheorthocladius Thienemann (in part), 1935, Stettin. Ent. Zeitg. 96:205.
Lapporthocladius Thienemann, 1937, Zool. Anz. 117:257.

Freeman also said that some of the species described by Kieffer in *Dactylocladius*, *Camptocladius*, and *Psectrocladius* may belong in *Orthocladius;* but they cannot be accurately placed at present.

A confusion of concepts exists in the literature with regard to the genus *Orthocladius*. The American workers have, for the most part, treated *Orthocladius* (and a number of other names) as a synonym of *Hydrobaenus* Fries. The most recent workers in Europe (Freeman, Brundin and Goetghebuer) treat these as distinct genera, with *Hydrobaenus* being monotypic and containing only *lugubris* Fries. The accepted concept of *Orthocladius sens. str.* seems to be that of Edwards' subgenus *Orthocladius* "group C" (1929b:336), but the type species of the genus is badly muddled in the literature. Kieffer (1906:26) designated *O. sordidellus* Zetterstedt as the type of the genus. Edwards (1929b:335) said "This designation was rather unfortunate, because *sordidellus* has been interpreted in various ways, and an examination of the type shows it to have distinct pulvilli and to belong to Kieffer's *Psectrocladius*. It is difficult to say precisely what Kieffer understood by *sordidellus*, but judging from the manner in which he restricted *Orthocladius* he may have had a species allied to *oblidens* Walk. All things considered, therefore, it seems best to regard *O. oblidens* as the genotype." Coquillett (1910:581) was obviously unaware of Kieffer's designation when he chose *Tipula stercorarius* DeGeer as the type of the genus. This species is not an *Orthocladius sens. str.;* Edwards (1929b:362) placed it in his subgenus *Smittia* "group C." Brundin (1947:39 and 1956:161) cites *stercorarius* as the genotype of *Camptocladius* van der Wulp. Goetghebuer (1942:31) designated still another species, *O. brevicornis* Kieffer, as the type of the genus. This species fits in *Eudactylocladius* Thienemann. The designations of Coquillet and Goetghebuer are, of course, not valid and in accordance with Opinion 65 of the Rules it would seem that *O. sordidellus* Zetterstedt should be the type species of *Orthocladius*, unless the case is presented to the International Commission and a decision made to the contrary. Strict adherence to the Rules would in this case lead to still more confusion and would again cause a change of concept in this genus. It appears that the only logical course is to follow Edwards in accepting *oblidens* as the type species, and it is hoped that one of the specialists in the group will present this case to the Commission and obtain their legal sanction for this action.

I am not following Freeman, Brundin, and others in treating *Smittia* Holmgren as a distinct genus. On the basis of the Hawaiian species, it certainly seems more logical to treat this as a subgenus of *Orthocladius*. The only distinction which I

find is that the squama has at least one or two hairs on the margin in *Smittia*, rather than being bare; in some cases this distinction seems to rest only upon the presence or absence of a single fine hair.

Thienemann (1935) gave biological details on European species of *Orthocladius*.

Type of genus: *Orthocladius oblidens* Walker, designated by Edwards (1929:335); refer to discussion above.

KEY TO THE KNOWN SPECIES OF ORTHOCLADIUS VAN DER WULP FROM HAWAII

1. Squama bare. **Orthocladius (Smittia)** Holmgren....... 2
   Squama with long hairs in the middle of the hind margin. **Orthocladius (Orthocladius)**................. 8

2(1). Vein R_{4+5} not fused with costa; Cu_2 extending to or near the wing margin.................................. 3
   Vein R_{4+5} fused with costa for two-thirds its length (fig. 42d); vein Cu_2 very short extending one-third the distance to the wing margin..... **paraconjunctus n. sp.**

3(2). Abdomen uniformly dark colored, mesonotum not with orange vittae.................................... 4
   Abdomen bright yellow, with a transverse brown mark over terga 2 to 5 and across the eighth tergum. Mesonotum yellow with orange vittae.................
   .... **maculiventris** (Edwards).

4(3). Costa ending at apex of vein R_{4+5}..................... 5
   Costa extending distinctly beyond R_{4+5}, at least one-third the distance to the tip of M................... 6

5(4). Thorax shining black in ground color covered with gray pollen. Legs brown. Fork of Cu situated near basal fifth of M....................... **campestris n. sp.**
   Thorax yellow, with brown vittae (fig. 43a). Legs pale. Fork of Cu opposite the basal third of M.. **wirthi n. sp.**

6(4). Predominantly dark brown to black species. Vein Cu_2 extending to or very near wing margin. Male antenna 14-segmented................................... 7
   Brownish yellow species. Vein Cu_2 ending well before wing margin (fig. 40c). Male antenna 13-segmented..
   .... **kauaiensis n. sp.**

7(6). Cu_2 straight or nearly so. Costa extending one-third the distance to the tip of M. Fork of Cu near basal two-fifths of M (fig. 42a)................ **oahuensis n. sp.**
   Cu_2 sinuate. Costa extending over one-half to tip of M. Fork of Cu opposite basal one-sixth of M (fig. 41d)..
   .... **mauiensis n. sp.**

8(1). Predominantly yellow species with brown vittae down mesonotum.................................... 9

All-black species, legs dark colored 10

9(8). Median brown vitta extending full length of mesonotum. Front with a row of seven or eight bristles above eyes. . . . . **williamsi n. sp.**

Median vitta extending only half the length of the thorax. Prescutellar area yellow. Front bare . . . . **grimshawi n. sp.**

10(8). Fork of Cu situated opposite the base of R_{4+5}. Flagellar segments of antenna swollen, no conspicuous membraneous structures present on antennae (fig. 38b). Halteres dusky. Neck of spermatheca straight (fig. 38c) . . . . **davisi n. sp.**

Fork of Cu situated well beyond base of R_{4+5}. Flagellar segments slender and each with conspicuous membraneous sensory structures (fig. 39a). Halteres yellow-white. Neck of spermatheca coiled (fig. 39c) . . . . **membranisensoria n. sp.**

Subgenus **ORTHOCLADIUS** van der Wulp

Orthocladius van der Wulp, 1874, Tijdschr. v. Ent. 17:132.

The members of the typical subgenus (as used here) differ from *Smittia* by having at least an incomplete fringe of hairs on the margin of each squama. On our species the fringe consists of from two (sometimes possibly one) to six long hairs on the margin. In most of our species the r–m crossvein is three or more times longer than the base of vein R_{4+5}, but this is evidently not a consistent character.

The eyes are bare. The wing membrane lacks distinguishable microtrichia. The pulvilli are lacking, and vein R_{2+3} is clearly separated from R_{4+5} and ends distinctly in the costa.

Type of subgenus: *Orthocladius oblidens* Walker; see discussion under the genus.

Orthocladius (Orthocladius) davisi, new species (figs. 38a–c)

This differs from other Hawaiian species by the black body and brown legs; by having the fork of cubitus near the r–m crossvein; by its larger size; by the last segment of the female antenna being nearly two times longer than the penultimate segment as well as by other details of body structure as described and figured below. It is closest to *O. membranisensoria* n. sp.; for the differences see the discussion under that species.

FEMALE. *Head:* Black, appendages brown to black. Antennae with no distinct sensory structures. Segments 3 to 5 are swollen in the middle and are less than two times longer than wide. Segment 6 is about four times longer than wide (fig. 38b) and approximately two times longer than segment 5. Segments 3 to 5 with four strong setae at basal third and two to four short setae just before apex. The apical segment has several moderately short setae about equal in size to those

near apices of other segments. The front is bare except for a pair of moderately strong bristles on each side above eyes. The eyes are bare, uniform in shape, with the inner margins nearly straight. The clypeus is bare or with but a few inconspicuous setae. *Thorax:* Gray dusted, subopaque, faintly shining black in ground color. Halteres brownish yellow. Pronotum deeply notched in the middle. No distinct vittae on the mesonotum. Vestiture of thorax brown to black. *Wings:* Distinctly gray, costa produced beyond the tip of vein R_{4+5}, extending about one-fourth the distance to where M should reach the margin; vein M fades out before reaching the wing margin. Fork of cubitus opposite the basal portion of R_{4+5}. Crossvein r–m approximately three times longer than the base of R_{4+5}. Radial veins brown, posterior veins faint. R_{2+3} distinct though lying close between R_1 and R_{4+5} (fig. 38a). First anal vein lies close to cubitus and extends half the length of vein Cu_2. Four to six setae are on the middle margin of the squama. *Legs:* Entirely brown to black. Spur of front tibia about one-third longer than the width of the segment. The middle tibiae each have a strong spur at apex, about one-third longer than the width of the segment, and one rather weak spur about two-thirds as long as the width of the segment. The hind tibiae each have a comb of strong setae which extends about two-thirds the length of the spur. The proportions of the tibiae to the basitarsi are as follows: Front legs, 130–84, mid-legs, 135–60, hind legs, 165–84. *Abdomen:* Brown, tinged with yellow in ground color and faintly covered with gray pollen. The cerci are broad, about as long as wide, rounded at apices. The narrowed entrances to the spermathecae are straight (fig. 38c).

Length: body and wings, 1.85 mm.

MALE. Unknown.

Holotype female: Kaula Gulch, Hawaii, 7,000 ft.; Aug., 1952 (D. E. Hardy). Nineteen paratypes: eight same data as type; nine from Puu Kalapa, Hawaii, "pond" 8,000 ft., Oct., 1952 (D. E. Hardy); and two from Keanakolu, Hawaii, 5,200 ft., Oct. 28–30, 1952 (C. P. Hoyt). One female on hand from Puu Kukui, Maui, June, 1953 (C. R. Joyce), seems to belong here; it is in poor condition. I also have a series of topotypes in alcohol.

The species is named after Mr. C. J. Davis, entomologist for the Board of Agriculture and Forestry formerly on the island of Hawaii. He accompanied me on field trips throughout the "Big Island" on many occasions and the valuable assistance he has given me is very greatly appreciated.

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. The remainder of the paratypes deposited in the following collections: U. S. National Museum, Hawaiian Sugar Planters' Association, and the University of Hawaii.

Orthocladius (Orthocladius) grimshawi, new species (figs. 38d–f).

This is apparently the species which Grimshaw (1901:5) reported (two females) from Haleakala, Maui, 5,000 ft.; March, 1894; not in good enough condition for description. It also is apparently the same as *Spaniotoma* #2 of Williams (1944: 164). Specimens have been compared with material from Mt. Kaala "at spring 3,600 ft." (the specimens mentioned by Williams) and they seem to be identical.

Similar to *O. williamsi* n. sp. but the median brown vitta on the back of the thorax extends only half the length of the mesonotum; vein Cu_2 is bent downward at apex; the first anal vein extends only about half the length of Cu_2; the r–m crossvein is only about two times longer than the base of R_{4+5}; only two or three hairs are on the margin of the squama; and the genitalia differ as shown in figures.

MALE. *Head:* Yellow, occiput brown; mouthparts yellow, tinged with brown; antennae brown. Compound eyes bare, reniform in shape, inner margin nearly straight. The last palpal segment is two-fifths longer than the penultimate segment. The antennae are 12-segmented; the last two are indistinctly divided. The last is slightly shorter than segments 8 to 11, inclusive. Front bare without any conspicuous setae; a moderately strong bristle is located on the vertex on each side of the eye margin. *Thorax:* Shaped as in *williamsi* with the front portion produced over the back of the head and the pronotum with a slight notch in the middle. Coloration also rather similar to *williamsi* except that the median vitta extends only about half the length of the mesonotum covering just the gibbose portion. The sunken area before the scutellum is yellow in ground color, tinged lightly with brown along the extreme hind margin. Scutellum yellow, tinged with brown. *Legs:* Yellow, tinged with brown. The hind tibiae each with a strong comb of eight to ten bristles, rather similar to figure of hind tibia of *williamsi;* the strongest bristles of the comb are nearly as strong as the tibial spur. The middle tibiae each have two moderately short spurs. The front has a single spur which is slightly longer than the width of the tibia. The tibiae are approximately two times as long as the basitarsi, on all legs. The proportions of the tibiae to the basitarsi are: front legs 80:38, middle legs 65:27, hind legs 65:35. *Wings:* (fig. 38e). Venation very similar to that of *williamsi* except that the r–m crossvein is shorter, only about two times longer than the basal section of R_{4+5}. The apical portion of Cu_2 is distinctly bent downward and 1st A ends at about the middle of Cu_2. *Abdomen:* The terga are brown, the venter is yellow. *Genitalia:* (Described from a paratype mounted on a slide.) Dististyli rather slender, about three-fifths as long as basistyli, densely covered with short, fine hairs, especially on inner side and terminating in a pair of spine-like processes, one short and one moderately long (fig. 38d). The basistyli each have a large bump (small lobe) at middle on inner margin (fig. 38d).

Length: 0.8 to 1.0 mm.

FEMALE. Fitting the description of the male except for sexual characters. The antennae are apparently like those of *williamsi*. The cerci are longer than wide (fig. 38f).

Holotype male, allotype female: Nahiku, Maui, Aug. 3, 1952 (N.L.H. Krauss). Eight paratypes: two males and two females, same data as type; one female, Olinda, Maui, 4,500 ft. elevation, Apr. 8, 1932 (O. Bryant); and two males and one female, from Makamakaole Valley, Maui, June 24, 1953 (D. E. Hardy). Also a series of specimens in alcohol from the latter locality. Nine females are on hand from Oahu, Kauai, and Hawaii which appear to belong here but are not being designated as paratypes: one from Ewa, Oahu, light trap, June, 1955; one,

Wheeler Field, Oahu, Nov., 1945 (W. W. Wirth); four, Mt. Kaala, Oahu "Gunnera spring," 3,600 ft., Mar. 1938 (F. X. Williams) and same locality, 4,000 ft., Aug., 1945 (W. W. Wirth); one, Akaka Falls, Hawaii, Mar., 1946 (W. W. Wirth); and one, Hilo, Hawaii, Mar., 1946 (W. W. Wirth). Also layered specimens from Akaka Falls, Hawaii; one, from Keaau Orchard, Olaa, Hawaii, Sept., 1956, light trap; and alcoholed specimens from Alakai Swamp, Kauai, 4,000 ft., Aug., 1953 (D. E. Hardy).

Type and allotype in B. P. Bishop Museum. Paratypes deposited in the following collections: U.S. National Museum, Hawaiian Sugar Planters' Association, University of Hawaii.

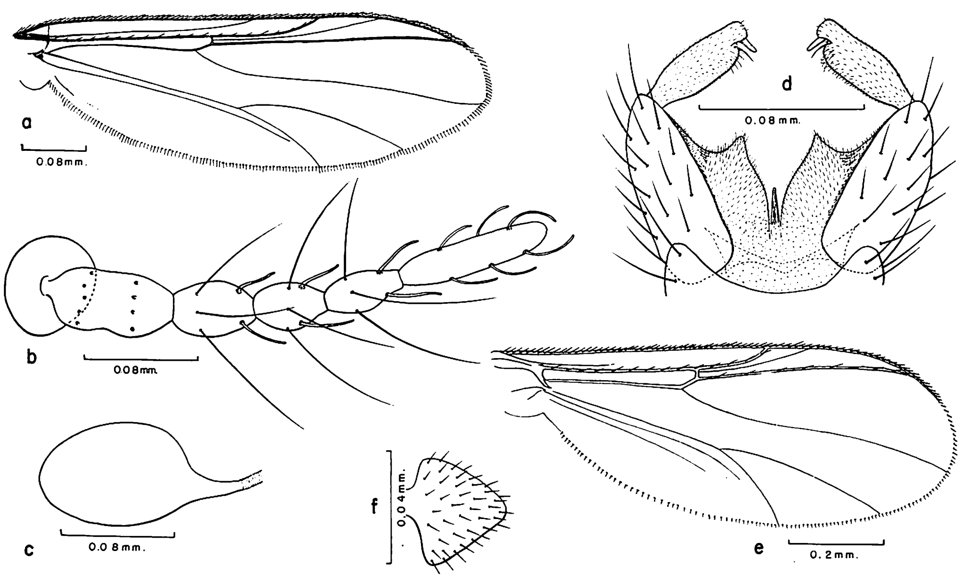

Figure 38—*Orthocladius* (*Orthocladius*) *davisi* n.sp.: **a,** wing; **b,** antenna; **c,** spermatheca. *O.* (*Orthocladius*) *grimshawi* n.sp.: **d,** male genitalia, ventral view; **e,** wing; **f,** cercus.

Orthocladius (Orthocladius) membranisensoria n. sp. (figs. 39a–c).

Closely related to *O. davisi*, the specimens were collected in the same habitat and were included originally in the series of *O. davisi* n. sp. It differs by having the body polished black and by the striking differences in the development of the antennae as well as in the sexual organs. The peculiar membranous sensory structures on the segments of the antennae and the curled necks of the spermathecae will differentiate it very readily; refer to figures 39a and c. Also, the pronotum is entire, not notched in the middle, the fork of cubitus is well beyond the r–m crossvein, and the halteres are bright yellow, not brownish, tinged with yellow.

FEMALE. Almost entirely shining black species. *Head:* Eyes reniform, the inner

margin slightly concave, devoid of pile. The antennal segments are comparatively elongate, rather parallel sided, not distinctly attenuated at apices. Segments 3 to 5 are four times longer than wide, and segment 6 is about five times longer than wide, and about two-thirds longer than the fifth. Segments 2 to 5 each have about four rather long black bristles at about the basal third and an oblong membranous area situated at about the apical third on each side (fig. 39a). The apical segment has three pairs of membranous sensory structures—one near basal third, one at about middle, and one near apex (fig. 39a). The front is broad, over three times wider than the basal segment of the antenna. Two to three moderately strong bristles are situated on each side of head above eyes. The clypeus has just a few setae. The last segment of the palpus is two-thirds longer than the penultimate segment. *Thorax:* The mesonotum is only gently arched and not strongly produced in front. The pronotum has no notch in the middle. The depressed portion of the mesonotum, the area of the hind corners, and the scutellum are faintly gray pruinose in direct light. The mesonotum and scutellum are very sparsely setulose, the former has a narrow groove extending down the middle of the anterior half. The metanotum is strongly grooved down the median portion and the halteres are yellow-white. *Legs:* Predominantly brown to black, the tibiae and basal tarsal segments tinged with yellow. The spur at the end of the front tibia is about equal in length to the width of the tibia. The middle tibiae each have two small, equal sized spines which measure less than the diameter of the segment. The bristles of the comb on the hind tibia are about half as long as the apical spine. The tibiae are over two times longer than the basitarsi; the proportions are as follows: front legs, 125:56, middle legs 120:44, hind legs 135:68. *Wings:* Faintly fumose in reflected light. Subcosta ends opposite the fork of cubitus; R_1 ends opposite about the basal third of vein Cu_1. Vein R_{2+3} is present although much more poorly developed than the other radial veins. The costa is developed beyond the tip of vein R_{4+5} extending about one-fifth the distance to apex of vein M. The r–m crossvein is about three times longer than the basal section of R_{4+5}. Vein M fades out just before the wing margin, as does vein Cu_2. The fork of cubitus lies well beyond the r–m crossvein. The first anal vein extends just beyond the fork of Cu; the apex is not noticeably bent downward (fig. 39b). The squamae each have six to eight long hairs in the middle of the hind margin. *Abdomen:* The terga are velvety black, the sterna are black, faintly gray pruinose. The cerci are longer than wide, and the spermathecae are coiled on their apices (the end of the duct). Refer to figure 39c.

Length: body and wings, 1.3–1.4 mm.

MALE. Unknown.

Holotype female: Kaula Gulch, Hawaii, 7,000 ft., Aug., 1952 (D. E. Hardy). Five paratypes: two same as type; three Keanakolu, Hawaii, 5,200 ft., Oct., 28–30, 1952 (C. P. Hoyt).

Type in B. P. Bishop Museum. Paratypes in the U.S. National Museum and the University of Hawaii collections.

Orthocladius (Orthocladius) williamsi, new species (figs. 39d–h).

Spaniotoma #3, Williams, 1944, Proc. Haw. Ent. Soc. 12:164.

Orthocladius (*Psectrocladius*) sp., Bryan, 1934, Proc. Haw. Ent. Soc. 8:404.

This is the species recorded by Bryan (1934) as an undescribed species "referred by Johannsen to the subgenus *Psectrocladius*." I have seen the specimen, evidently determined by Johannsen. It is a female from Makaleha, Mt. Kaala, Oahu, Jan. 8, 1922 (O. H. Swezey), and it is quite obviously the same as *Spaniotoma* #3 of Williams. It does not have the pulvilli developed and will not fit in the subgenus *Psectrocladius* Kieffer. Apparently this subgenus does not occur in Hawaii.

A small, predominantly yellow species with three brown vittae on the mesonotum. It is differentiated from related species by the median vitta extending the entire length of the mesonotum (fig. 39d). FEMALE. *Head:* Yellow, occiput and clypeus brown, tinged with yellow. Eyes small, round and bare. Front broad, four times wider than the bases of the antennae. Palpi and antennae yellow, tinged with brown; the former are the more elongate, extending well beyond apices of antennae. The apical segment of the palpus is about one-fifth longer than the penultimate segment. The antennae are 6-segmented; the last two segments are approximately equal in length. *Thorax:* The mesonotum is rather strongly produced, extending over the hind part of the head so that from a direct dorsal view the portion behind the antennae is not visible. The pronotum is complete and distinctly notched in the middle. A narrow brown line extends from the notch on pronotum all the way down the mesonotum to the scutellum; this is bordered on the anterior half by dark yellow, tinged with brown, which extends over the gibbose median portion of the mesonotum. Also the posterior margin of the mesonotum is narrowly bordered with brownish yellow, connecting the median vitta with the brown lateral vittae. The lateral vittae extend about three-fifths the length of the mesonotum (fig. 39d). The scutellum, pleura, and halteres are yellow; the former has eight rather strong yellow bristles. The margin of the metanotum is tinged with brown. *Legs:* Yellow, except for brownish tinged tarsi. The pulvilli are lacking, the empodium is well developed. The apex of each front tibia has a single rather strong spine which is about equal to the width of the tibia. Each middle tibia has two short spines at the apex, and the hind has a strong comb consisting of eight to ten bristles which extend two-thirds to three-fourths as long as the single apical spine (fig. 39e). Apex of hind tibia as in figure 39f. The proportions of the tibiae to the basitarsi are: front legs 105:65, middle legs 105:45, hind legs 130:70. *Wings:* Gray fumose, the squamal fringe in the specimens at hand consists of four to six hairs on the margin in the middle of the lobe. The r–m crossvein is about three times longer than the basal section of vein R_{4+5}. The fork of cubitus is slightly beyond a point opposite tip of subcosta, well before the apex of vein R_1. Vein R_{2+3} is fairly distinct and lies very close between R_1 and R_{4+5}. The costa extends just slightly beyond the apex of R_{4+5}. Vein Cu_2 is straight and is slightly over half the length of Cu_1. The first anal vein extends almost to the wing margin and is curved downward slightly beyond the fork of cubitus. The radial veins, except for the less distinct R_{2+3}, are entirely setulose except for the short basal section of R_{4+5}; the other veins

are bare. *Abdomen:* Yellow; the terga are tinged with brown. The cerci are short and broad, about as wide as long (fig. 39h).

Length: body and wings, 1.4 mm.

MALE. Unknown.

Williams (1944) reared this species in the laboratory at Honolulu and made the following comments on the immature stages. "The eggs measure about 0.24 mm. long. A well grown larva has a well developed anterior proleg; the posterior proleg is less developed and is sparsely provided with a few strong hooks. The larvae kept more or less submerged in some felt-like algae. They were unable to swim. The pupa much resembled that figured (36) from Mt. Kaala. It is provided with three bristles on each side near the eyes, while at the caudal end are two spines on each side of the gently bilobed median part, the outer spine the longer. The abdomen is finely roughened."

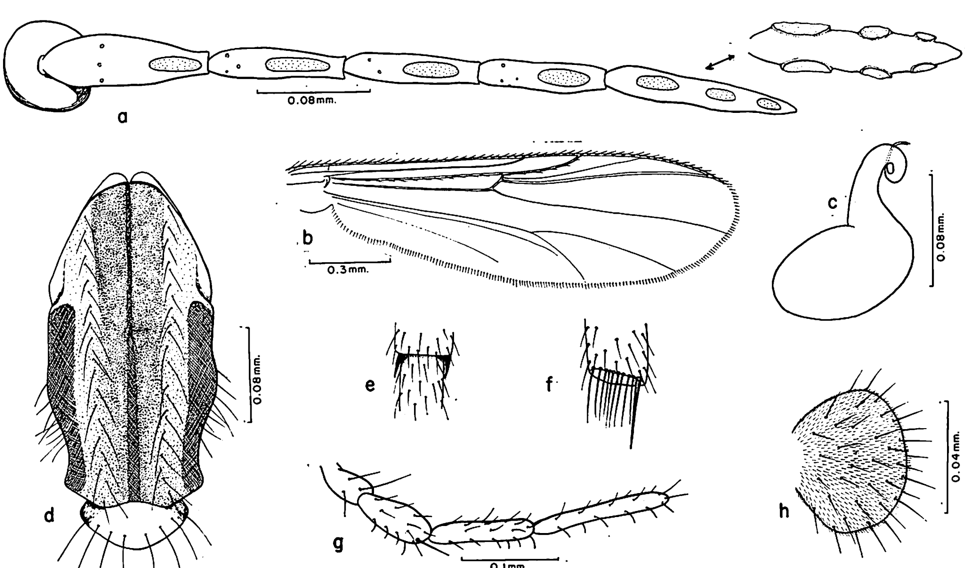

Figure 39—*Orthocladius* (*Orthocladius*) *membranisensoria* n.sp.: **a,** antenna; **b,** wing; **c,** spermatheca. *O.* (*Orthocladius*) *williamsi* n.sp.: **d,** thorax; **e,** apex of middle tibia; **f,** apex of hind tibia; **g,** palpus; **h,** cercus.

Holotype female: Honolulu, H.S.P.A. Expt. Sta., June 14, 1939 (F. X. Williams). Seventeen paratypes, all females, from the following localities: Honolulu, Oahu, on windows, Jan. to Apr., 1937, on "wet trash, 1,500 ft.," Feb., 1937 (F. X. Williams), on bean leaf, Apr., 1949 (M. S. Adachi), and at light, May, 1952 (D. E. Hardy); Pupukea trail, Oahu, Apr., 1952–Sept., 1953 (D. E. Hardy); Makaleha, Mt. Kaala, Oahu, Jan., 1922 (O. H. Swezey); Wheeler Field, Oahu, Nov., 1945 (W. W. Wirth), and Hilo, Hawaii, Mar., 1946, "light trap" (W. W. Wirth).

Type and a series of paratypes returned to the Hawaiian Sugar Planters' Association collection. The remainder of the paratypes deposited in the following collections: U.S. National Museum; British Museum (Natural History); B. P. Bishop Museum, and the University of Hawaii.

Subgenus **SMITTIA** Holmgren

Smittia Holmgren, 1869, Kongl. Svenska Vetenskaps Akad. Handl. 8:47.
Camptocladius van der Wulp (in part), 1874, Tijdschr. v. Ent. 17:133.
Phaenocladius Kieffer, 1921, in Thienemann, Arch. Hydrob. Planktonk., Suppl. 2(4):845.

For complete synonymy refer to Freeman (1956:346) and to Brundin (1956:146).

Edwards (1929:357 and 1935:89) defines *Smittia* as having the squamae bare, the wing membrane devoid of microtrichia, more or less milky by reflected light and slightly tinged with brown or purplish by transmitted light; vein R_{2+3} separate from R_{4+5} and fork of cubitus well beyond r–m; eyes bare or very short haired, and pulvilli rudimentary or absent. In our species the r–m crossvein is short, scarcely longer than the basal section of R_{4+5}; the first anal vein extends beyond the fork of Cu, is curved downward slightly toward apex, and evanesces before reaching wing margin. All of our species differ from *Smittia* (*Pseudosmittia*) *insulsa* Johannsen from Guam in this regard.

Type of subgenus: *Smittia brevipennis* Holmgren.

I am probably wrong in my treatment of this group. Brundin (1956:146) places *Smittia* as a distinct genus, in a different tribe (Metriocnemini) from *Orthocladius*. I fail to find characters in the Hawaiian species (which seem to be *Smittia*) which are significant enough to be of more than subgeneric importance.

Orthocladius (Smittia) campestris, new species (figs. 40a–b).

Related to *O. wirthi* n. sp., by having the costa ending at the apex of R_{4+5}. It differs by having the thorax shining black in ground color covered with gray pollen and the legs brown, rather than having the thorax marked with yellow vittae and the legs pale.

FEMALE. *Head:* Dark brown to black, antennae brown, palpi brownish yellow. Eyes oval, inner margin nearly straight. Antennae 6-segmented, segments not strongly attenuated apically. The last segment is approximately equal to the preceding two (fig. 40a). Four rather strong, pale bristles are present on each side of head above eyes. *Thorax:* Entirely shining black covered with gray pollen except for a yellow tinge at wing bases, on upper edges of pleura and for a faint tinge on edges of humeri. Pronotum entire, without a median notch. Halteres yellow. *Legs:* Brown, tinged with yellow. Bristles of comb on hind tibia extend about two-thirds the length of tibial spines. The proportions of the tibiae to the basitarsi are as follows: front legs 75:34, middle legs 83:50, hind legs 85:38. *Wings:* Faintly milky; the posterior veins are almost hyaline, those along the anterior margin are slightly yellow. The costa ends at vein R_{4+5}; the subcosta

ends slightly beyond the basal portion of R_{4+5}. The fork of Cu is situated about opposite the basal one-fifth of vein M. Cu_2 reaches almost to the wing margin and is very slightly curved. The second anal vein is nearly straight and extends almost two-thirds the length of Cu_2. The r–m crossvein is approximately two times longer than the basal portion of R_{4+5}. *Abdomen:* All black covered with gray pollen and with rather long yellow-white hairs. The cerci are about as long as high; the spermathecae are tiny, about one-fourth the size of the cerci and with short straight ducts (fig. 40b).

Length: body, 1.3 mm.; wings, 1.5 mm.

MALE. Similar to female, terminal segment of antenna almost as long as preceding six segments. Lobes on inner apices of basistyli rather slender, sharp-pointed, converging on the specimens studied.

Holotype female, allotype male (on slide), and 11 female paratypes: Ewa, Oahu; March 15 and March 25, 1946; swept ex sedges and grasses near pond (W. W. Wirth). One paratype female: Ewa, Oahu, light trap, June, 1955 (J. W. Beardsley); one paratype female: Kalihi, Oahu, July 2, 1946, hyacinth-choked ditch (W. W. Wirth). Also, one paratype male: Mt. Tantalus, Oahu, July 8, 1945 (W. W. Wirth).

Type, allotype, and a series of paratypes are in the U.S. National Museum. The remainder of the paratypes are in the collection of B. P. Bishop Museum, British Museum (Natural History), and University of Hawaii.

Orthocladius (Smittia) kauaiensis, new species (figs. 40c–e).

Distinguished from other Hawaiian species by the uniformly yellow-brown coloration and short Cu_2. Somewhat resembles *O. wirthi* n. sp., but the costa extends distinctly beyond R_{4+5} and Cu_2 ends well before the wing margin (fig. 40c). It also differs from all other *Orthocladius* by having just 13 segments in the antenna of the male with the apical segment comparatively short.

MALE. *Head:* Eyes oval, inner margin nearly straight. Antennae 13-segmented, apical segment comparatively short, not quite as long as segments 9 to 12. The apical three-fifths of the last segment possesses no long bristles but just long pubescence. Antennae rather sparsely plumose, apparently with just four long hairs on each segment. The last segment of the palpus is one-third longer than the penultimate segment (fig. 40d). There are three strong brown bristles on each side of the head above the eyes. *Thorax:* Entirely yellow, lightly tinged with brown. Mesonotum not distinctly vittate but slightly paler in posterior median depression and on the anterior corners; and a faint, very narrow, brown line extends down the median portion. Dorsocentral bristles strong and brown, extending almost the full length of mesonotum from opposite wing bases to humeri. *Legs:* Femora tinged with brown. The tibiae and basitarsi are approximately the same length on all legs. The former are about twice as long as the latter. The proportions are as follows: front legs 63:40, middle legs 65:40, hind legs 65:40. *Wings:* Pale brownish in transmitted light; the costa extends about one-third the distance between tips of R_{4+5} and vein M. The r–m crossvein is over three times longer

than the basal section of R_{4+5}. The fork of cubitus is situated just before a point opposite the tip of R_1 and near the basal one-fourth of vein M. Vein Cu_2 is slightly curved and evanescing well before the wing margin. The first anal vein is straight and extends just beyond the fork of cubitus (fig. 40c). *Abdomen* and *genitalia:* Entirely yellow-brown with pale vestiture. The ninth tergum is rectangular. The hind margin is nearly straight. The dististyli are short, about one-third as long as basistyli, thickened on basal halves. The basistyli each have a triangular lobe on inner margin near apex (fig. 40e).

Length: body, 1.2 mm.; wings, 1.0 mm.

FEMALE. Fitting the description of the male except for sexual characters. The antennae are 6-segmented. The apical segment is slightly longer than the two preceding segments.

Length: body and wings, 1.0 mm.

Holotype male, allotype female, and 13 paratypes (5 males, 8 females), from Nawiliwili, Kauai, Sept. 8, 1946, at light (W. W. Wirth).

The type, allotype, and a series of paratypes have been returned to the U.S. National Museum. The remainder of the paratypes are being deposited in the following collections: B. P. Bishop Museum, British Museum (Natural History), and the University of Hawaii.

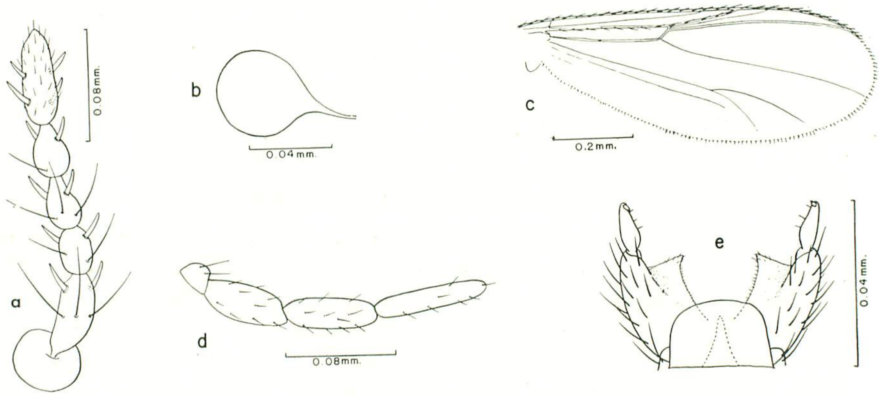

Figure 40—*Orthocladius* (*Smittia*) *campestris* n.sp.: **a,** antenna; **b,** spermatheca. *O.* (*Smittia*) *kauaiensis* n.sp.: **c,** wing; **d,** palpus; **e,** male genitalia, dorsal view.

Orthocladius (**Smittia**) **maculiventris** (Edwards), new combination (figs. 41a–c).

Spaniotoma (*Smittia*) *maculiventris* Edwards, 1935, B. P. Bishop Mus. Bul. 114:89.

Oahu, Hawaii, and Kauai.

Immigrant. Described from the Marquesas from one male on dead banana leaves.

Type in British Museum (Natural History).

The only record for this species in our literature is that of Williams (1944:164). He found the males hovering in swarms over leaf compost and females sitting on vegetation nearby. It is probably rather common and is perhaps widespread in the Islands, but is easily overlooked because of its very small size. It has been taken rather commonly in light-trap material from Ewa, Oahu, and from several parts of Honolulu. I also have seen it in light-trap catches from Hilo, Hawaii, and Lihue, Kauai.

A very tiny species; easily recognized, however, by its distinctive markings. The mesonotum is largely brownish yellow or orange. The posterior median portion is yellow, the shoulders are whitish as are the face and mouthparts. The pleura are mostly yellow-brown. The head (except the eyes and face), the scutellum, halteres, legs, and most of abdomen are yellow. The latter has a transverse brown to black band extending across terga 2 to 5 and the eighth tergum is marked with brown; these bands are broader, and more extensive in the females. The antennae of the male are densely plumose, 14-segmented, with the last two segments indistinct. The wing membrane is bare and glassy hyaline. Vein R_{4+5} ends about opposite the middle of vein Cu_1 and the costa ends about opposite the tip of Cu_1, extending about one-third the distance to the tip of vein M. The fork of Cu is opposite the tip of R_1. Cu_2 bends downward rather sharply beyond the middle and 1st A extends well beyond fork of Cu and is curved to apex (fig. 41a). The eyes are microscopically haired; the setae are very short and visible only under high magnification. The palpi are as in figure 41c. The dististyli of the male genitalia are very small and terminate in a sharp point on inner apices (fig. 41b).

Length: body and wings, 0.9 to 1.0 mm.

Orthocladius (Smittia) mauiensis, new species (figs. 41d–f).

Similar to *O. oahuensis* n. sp., but Cu_2 is sinuate, the costa extends over one-half the distance to the tip of M, and the fork of Cu is near base of M opposite the basal one-sixth to one-seventh of M (fig. 41d).

FEMALE. *Head:* Dark brown, antennae and palpi brownish yellow. Apical antennal segment somewhat swollen, two-thirds longer than the penultimate segment. Segments 2 to 5 slightly attenuated apically. (Figure 41f drawn from paratype.) The last segment of the palpus is one-half longer than the penultimate segment. Three to four rather strong dark bristles on each side of head above eyes. *Thorax:* Entirely dark brown except for brownish yellow scutellum and yellow halteres. Upper portions of pleura also tinged with yellow. Pronotum entire, no evident notch in the middle portion. *Legs:* Yellow, femora tinged with brown. Comb of hind tibia with rather long setae extending two-thirds the length of the spine. The proportions of the tibiae to the basitarsi are as follows: front legs 70:38, middle legs 70:45, hind legs 73:40. *Wings:* Milky in reflected light, slightly brownish in refracted light. The costa extends approximately half the distance to the tip of vein M. Fork of cubitus situated well before the tip of R_1 about opposite the apex of subcostal vein and near the base of M. Cu_2 rather strongly sinuate, extending almost to wing margin. First anal vein slightly curved, extending one-

third the length of Cu_2 (fig. 41d). *Abdomen* and *genitalia:* Entirely dark brown. Vestiture pale; cerci nearly circular, slightly higher than long; spermathecae oblong with short straight ducts (fig. 41e).

Length: body, 1.0 mm.; wings, 1.3 mm.

MALE. Unknown.

Holotype female, three paratypes: Haleakala, near Puu Nianiau, Maui, 6,200 ft., July 21, 1919 (Walker). Two paratypes: Kula Pipeline, Maui, 4,500 ft., March 19, 1932 (O. Bryant); one paratype: Halemanu Trail, East Maui, May 1, 1945, "*Deschampsia,*" 8,000 ft. (E. C. Zimmerman).

The type and two paratypes are in the B. P. Bishop Museum. The remainder are being deposited in the following collections: U.S. National Museum and the University of Hawaii.

This may possibly be the *Orthocladius* sp. recorded by Grimshaw (1901:5) from Haleakala.

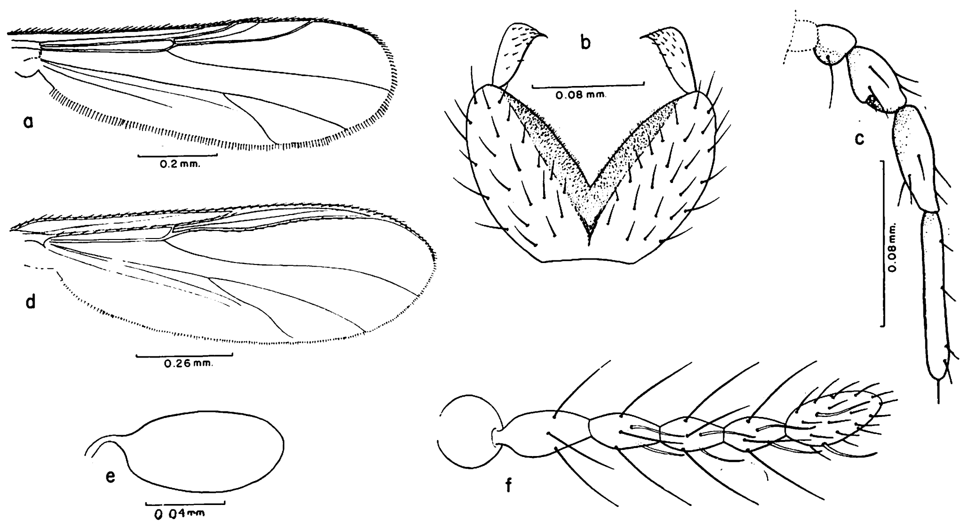

Figure 41—*Orthocladius* (*Smittia*) *maculiventris* (Edwards): **a,** wing; **b,** male genitalia, ventral view; **c,** palpus. *O.* (*Smittia*) *mauiensis* n.sp.: **d,** wing; **e,** spermatheca; **f,** female antenna.

Orthocladius (Smittia) oahuensis, new species (figs. 42a–b).

Related to *O. mauiensis* n. sp., but the costa is shorter, the fork of Cu is near the basal one-third of M, and Cu_2 is nearly straight. The male genitalia are distinctive (fig. 42b). The species appears closest to *Orthocladius macrobrachius* Edwards (1928:62) from Samoa. Edwards (1935:89) indicated that this is a *Spaniotoma* (*Smittia*) but differs from Edwards' original description by having the apical antennal segment slightly longer than the remainder of antenna. In *O. Macrobrachius* the last antennal segment is about 0.7 as long as segments 2

to 13. Edwards also says the inner lobe is situated at about the middle of the basistylus; in *oahuensis* it is near the apex (fig. 42b). Also in *oahuensis*, R_{4+5} ends about opposite the tip of Cu_1, not well before it, and the costa extends about one-third to M, not "nearly half way."

MALE. *Head:* Chiefly brown to black, clypeus bright yellow, antennae and palpi yellow-brown. Antennae densely plumose, apical fifth of last segment long, pubescent; the apical segment is slightly longer than the remainder of the antenna. There are three rather strong brown bristles on each side of the head above eyes. *Thorax:* Pronotum entire, narrow, without median notch. Mesonotum chiefly shining black, lightly gray pollinose; humeri yellow; upper portions of pleura, halteres, and wing bases yellow. Scutellum with two strong bristles on hind margin, about two times longer than scutellum, and also with several small bristles. Dorsocentral bristles rather strong. *Legs:* Brownish yellow, the comb of hind tibia strong, the bristles are nearly as long as tibial spines. The proportions of the tibiae to the basitarsi are as follows: front legs 115:63, middle legs 120:65, hind legs 130:63. *Wings:* Faintly brown fumose in transmitted light; the costa extends about one-third the distance to vein M. The fork of cubitus is situated just before the tip of vein R_1 at about the basal third of vein M. The r–m crossvein is nearly three times longer than the basal section of R_{4+5}. Vein Cu_2 is straight and extends approximately to the wing margin. The first anal vein is straight and ends just beyond the fork of cubitus (fig. 42a). *Abdomen* and *genitalia:* Entirely dark brown to black with pale vestiture. The dististyli are paralled-sided, about half as long as basistyli and with a small blunt tooth at apex. Each basistylus has a moderately developed blunt lobe on the inner margin near the apex (fig. 42b).

Length: body, 2.2 mm.; wings, 1.9 mm.

FEMALE. Unknown.

Holotype male and 15 paratypes: Mt. Kaala, Oahu, July 25, 1946, taken at summit in bog, 4,000 ft. (W. W. Wirth). Five paratypes: Poamoho trail, Oahu, July 31, 1946, "swarming at wet bank" (W. W. Wirth); one paratype: Mt. Tantalus, Oahu, June 23, 1935 (R. L. Usinger).

Type and a series of paratypes deposited in the U.S. National Museum. Other paratypes are in the B. P. Bishop Museum, British Museum (Natural History), Hawaiian Sugar Planters' Association, and the University of Hawaii collections.

Orthocladius (Smittia) paraconjunctus, new species (figs. 42c–f).

Very close to *O. conjunctus* (Edwards) (1929:365) and inseparable from the original description. Mr. Paul Freeman kindly compared specimens of this with Edwards' type in the British Museum (Natural History). He reported that the type series of *conjunctus* have the thorax completely black and slightly shining. Edwards in his original description says "shoulders and wing-bases yellow." This apparently was an error. I have studied a paratype (loaned from the British Museum collection). The top of the thorax, including the humeri, is entirely black, the upper portions of the pleura, below the humeri and at wing bases, are yellowish to rufous. *O. paraconjunctus* is velvety black on the mesonotum, the scutellum is black rather than yellow-brown to rufous, and vein Cu_2 is more poorly developed

than in *conjunctus*. (Compare figure 42d and Edwards' figure 14, plate XVIII.) Since *conjunctus* is known only from six females from England, it is most probable that the Hawaiian specimens represent a distinct species.

This species fits in a group of three species—*O. conjunctus* (Edwards), Great Britain; *O. subaptera* (Goetghebuer), northeastern shores of Caspian Sea; and *brachyptera* (Goetghebuer), Belgium—which are distinct from all other *Orthocladius* (*Smittia*) by having vein R_{4+5} fused with the costa. The latter two species have rudimentary wings, while in *conjunctus* the wings are normal in length. Goetghebuer (1943:105) treated this group under the combination *Smittia* (*Pseudosmittia*). The wing venation of these species somewhat approaches that of *Corynoneura* Winnertz, but in that genus all of the radial veins are fused with the costa, a false vein is present near the anterior margin of the wing, and the legs are very differently developed.

Males are completely unknown in this group and it is probable that the species reproduces parthenogenetically.

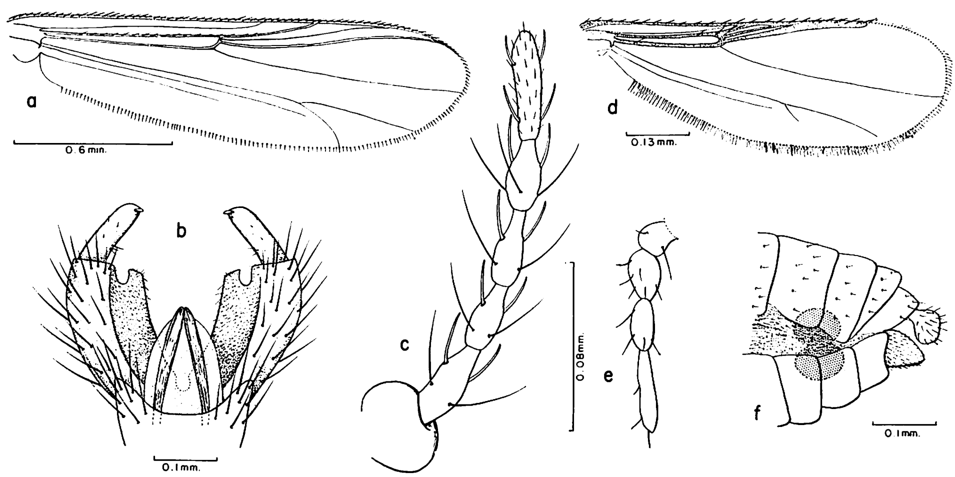

Figure 42—*Orthocladius* (*Smittia*) *oahuensis* n.sp.: **a,** wing; **b,** male genitalia, ventral view. *O.* (*Smittia*) *paraconjunctus* n.sp.: **c,** female antenna; **d,** wing; **e,** palpus; **f,** apical segments of female abdomen.

FEMALE. Predominantly dull, rather velvety, black; shoulders and wing bases yellow. The specimens from the Koolau Mountains have the depressed area in front of the scutellum brownish, tinged with yellow and have a brownish yellow line extending down each dorsocentral area connecting up with the pale spots on the shoulders so that three black vittae are marked off on the mesonotum. The specimens from the Waianae Mountains have the mesonotum predominantly black. *Head:* The palpi are about equal in length to segments 1 to 4 of the antennae; the terminal segment is approximately as long as the two previous segments (fig. 42e). The antennae are six-segmented, the apical segment is about one-half longer than the penultimate segment; segments 2 to 5 have rather long

necks; the attenuated portions are nearly one-half as long as the nodes (fig. 42c). The halteres are yellow, faintly tinged with brown. The legs are yellowish brown. The fourth tarsal segment is shorter than the fifth and not much longer than wide. *Wings:* As in figure 42d. The costa extends to about the apical three-fourths of the wing. Vein R_{2+3} is apparently present but lies so close to R_{4+5} that it is not visible except when the wing is flattened on a microscope slide and viewed under high power (fig. 42d). Vein Cu_2 very short, extending only about one-third the distance to the wing margin. They differ in this regard from Edwards' figure of *conjunctus* (1929, pl. 18, fig. 14), in which he shows vein Cu_2 extending about two-thirds the distance to the margin. The anal lobe is lacking. *Abdomen:* Velvety black on the dorsum, brown on the venter. The cerci are higher than long and the spermathecae are nearly circular; the ducts are apparently not sclerotized (fig. 42f).

Length: body, 0.6 to 0.7 mm.; wings, 0.7 to 0.8 mm.

This is the smallest species of chironomid known from Hawaii and is one of the smallest known from the entire world.

MALE. Unknown.

Holotype female and 13 paratypes: Mt. Kaala, Oahu, swept from grass in bog, 4,000 ft., Aug. 22, 1945 (W. W. Wirth); 18 paratypes: from Pupukea Ridge Trail, Oahu, swept from lush vegetation along trail, 2,000 ft., Sept. 9, 1955 (D. E. Hardy).

Type and a series of paratypes in U.S. National Museum. Remainder distributed among the following collections: B. P. Bishop Museum, British Museum (Natural History), Hawaiian Sugar Planters' Association, and University of Hawaii.

Orthocladius (Smittia) wirthi, new species (figs. 43a–c).

Resembles *Orthocladius* (*Orthocladius*) *williamsi* n. sp. because of the bright yellow markings of the thorax, but the squamae are bare and the wing venation is quite different. It fits next to *O. campestris* n. sp. in my key, but that species is all black and the fork of cubitus is near the basal fifth of vein M rather than at the basal third.

MALE. *Head:* Yellow, tinged with brown, including antennae but excepting eyes; palpi yellow. Eyes oval. Three to four rather strong bristles are situated on each side of head above eyes. Antennae densely plumose, 14-segmented, last segment approximately equal to segments 9 to 13. Palpi slender, last segment about equal in length to the two preceding segments (fig. 43b). *Thorax:* Bright yellow on upper portions of pleura, anterior corners, and lateral margins of mesonotum, and with a narrow yellow vitta running down each dorsocentral area (fig. 43a). The depressed portion in front of the scutellum is yellow, tinged with brown. The mesonotum has three brown vittae as in *Orthocladius williamsi;* the median vitta extends the full length of the mesonotum although it is somewhat more faint on the posterior half. The scutellum is yellow-brown, the halteres are yellow. The pronotum is apparently entire and there is no indication of a median notch; the median portion is obscured from direct dorsal view by the projected front margin

of the mesonotum. *Legs:* Yellow, faintly tinged with brown. The combs of the hind tibiae are strong; the longest bristles extend nearly as long as the tibial spine. The proportions of the tibiae to the basitarsi are as follows: front legs 65:35, middle legs 67:35, hind legs 70:40. *Wings:* Faintly brown in transmitted light. The costa ends at the tip of R_{4+5}. Vein R_{2+3} ends about half way between R_1 and R_{4+5}. The fork of cubitus is about opposite the tip of R_1 and situated near the basal one-third of vein M. Cu_2 is nearly straight and extends approximately to the wing margin. The first anal vein is straight and ends just beyond the fork of cubitus. *Abdomen:* Dark brown to black with pale vestiture. *Genitalia:* The styli are yellow, tinged with brown. (The structural details are taken from a paratype mounted on a slide.) Ninth tergum slightly wider than long, gently convex on posterior margin. The dististyli are slender, rather parallel sided, about half as long as the basistyli, and with a small blunt tooth at apex. Inner margins of basistyli straight; inner apices with a moderately strong blunt lobe as in figure 43c.

Length: body, 1.3 mm.; wings, 1.13 mm.

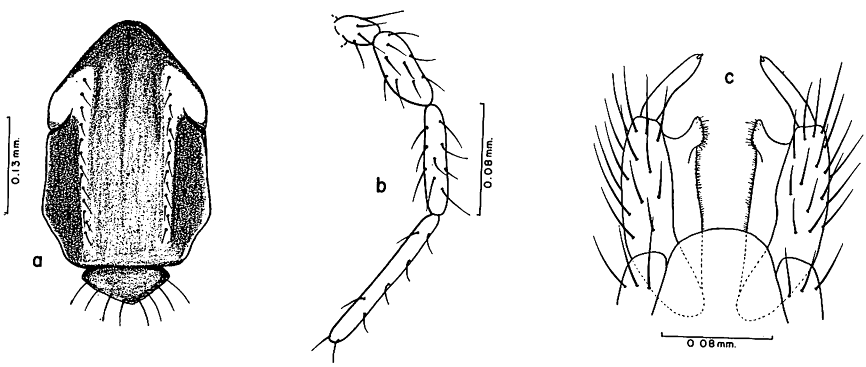

Figure 43—*Orthocladius (Smittia) wirthi* n.sp.: **a,** mesonotum, dorsal view; **b,** palpus; **c,** male genitalia, dorsal view.

FEMALE. Fitting the description of the male except that the specimens are more extensively yellow; the apex and venter of the abdomen and all of the pleura except the sternopleura and hypopleura are bright yellow. The antennae are six-segmented. The apical segment is approximately as long as the two preceding segments.

Holotype male, allotype female from Kalihi, Oahu, July 2, 1946, "hyacinth choked ditch" (W. W. Wirth). Sixteen paratypes (11 males and 5 females): 3, same data as type; 6, Ewa, Oahu, Mar. 15, 1946, "swept ex sedges near pond" (W. W. Wirth); 1, Ewa, Oahu, light trap, June, 1955; 2, Hilo, Hawaii, Mar. 2, 1946, "on rocks near sea at hospital" (W. W. Wirth); and 4, Mahukona, Hawaii, Feb. 28, 1946, "swarming over rocks at sea" (W. W. Wirth).

Type, allotype, and a series of paratypes in the U.S. National Museum. The

remainder are in the collections of the B. P. Bishop Museum and the University of Hawaii.

Genus **METRIOCNEMUS** van der Wulp

Metriocnemus van der Wulp, 1874, Tijdschr. v. Ent. 17:136.

This genus is distinguished from other known members of the *Orthocladiinae* in Hawaii by having the wings hairy and having distinct macrotrichia on the membrane, especially at the apex. Also in our species the eyes are bare; the male antennae contain 14 segments, those of the female are six-segmented; the pulvilli are absent; the pronotum forms a distinct collar; the mesonotum is not produced in front; the squamae are bare; the male diststyli are simple and the basistyli lobate on inner apices. Brundin (1956:121) places *Metriocnemus* and related genera in a separate tribe, Metriocnemini. Just one species is known from Hawaii; it fits in the subgenus *Metriocnemus*.

Johannsen (1937a:46) said "Most of the species of *Metriocnemus* may be found in streams; two American species are found in the water of pitcher-plants." The immature stages are characterized by the elongate preanal papillae and straight first antennal segment of the larvae and by the closely set, blunt warts which fringe the posterior margin of most of the terga in the pupae.

Type of genus: *M. fuscipes* (Meigen).

Metriocnemus herbicolus, new species (figs. 44a–d).
Metriocnemus #1 Williams, 1944, Proc. Haw. Ent. Soc. 12:165.
Metriocnemus #2 Williams, 1944, Proc. Haw. Ent. Soc. 12:165.

This is obviously the species which Williams recorded from Mt. Olympus, Koolau Mts., Oahu, 2,100 ft., reared from muddy moss, Feb. 2–9, 1939; and from Mt. Kaala, Oahu, Nov. 13, 1937, 3,600 ft., on foliage. These all appear to be one species. I see no reliable characters by which they might be separated. In keys given by Coe (1950:141) and Goetghebuer (1940:6), this species runs to *M. atriclavus* Kieffer; the male genitalia, however, are very different from those of *atriclavus* as figured by Goetghebuer (1940:fig. 34). In Johannsen (1952:15) it runs to *M. exagitans* Johannsen (= *brachyneura* Malloch), but does not fit the description of this species. I am unable to ally it with any species known from the Pacific region.

MALE. Almost entirely opaque black. *Head:* Entirely brown to black including the appendages. Eyes bare, oblong in shape, inner margins almost straight. Front broad, the width equal to the bases of the antennae. The front has three strong bristles on each side above eye margin. The clypeus contains about a dozen strong bristles. Antenna densely plumose; the apical portion, distinctly enlarged, club-shaped. This enlarged portion is devoid of long plumes but is thickly covered with rather fine pile. The apical segment is equal in length to the remainder of the antennal flagellum (segments 3 to 13, inclusive). The palpi are four-segmented, the second segment slightly swollen; the third and fourth are slender, parallel sided, and the fourth is one-half longer than the third. *Thorax:* Predominantly

black; yellow on the upper portions of the mesopleura, at the wing bases, and the area around the bases of the halteres; also, the anterior corners of the mesonotum are slightly yellow in ground color. The mesonotum is subopaque black with a line of gray pollen extending down each dorsocentral area; this is more distinct on the posterior portion. The median portion of the pronotum is hidden by the front margin of the mesonotum; there is apparently no median notch present. *Legs:* Almost entirely brown to black, trochanters and bases of femora tinged with yellow. The hind tibiae each have a well-developed comb and a single strong spur at apex. The bristles of the comb are approximately half as long as the spur. The tibiae are all approximately the same length; the proportions of the tibiae to the basitarsi are as follows: front legs 68:35, middle legs 67:32, hind legs 68:40. *Wings:* Rather thickly covered with macrochaetae, slightly brownish in refracted light. The costa is produced beyond the apex of vein R_{4+5} and extends approximately one-sixth the distance to the tip of vein M. The r–m crossvein is approximately four times longer than the basal portion of R_{4+5}. The fork of cubitus is located at the apical third of the wing, at about the middle of the median vein. Vein 1st A straight, ending just beyond the fork of Cu. Veins M, Cu_1, and Cu_2 evanescing before the wing margin (fig. 44a). Vein R_{2+3} distinct thought faint. Squamae entirely bare. *Abdomen:* Slender, thickly black haired, opaque black in color with narrow apices and bases; terga faintly gray. *Genitalia:* The basistyli are expanded apically and somewhat narrowed basally, and each has a strong thumb-like lobe developed on the inner margin near the apical third. The dististyli are rather slender and have a small blunt lobe developed just below the apex (fig. 44c). The ninth tergum is small, sharply pointed; it is longer than wide and extends only about one-third the length of the basistyli. The anal region is membranous and is produced into an almost truncate portion which lies immediately below the tergum which is slightly concave at apex (fig. 44d).

Length: body, 1.5 mm.; wings, 1.2 mm.

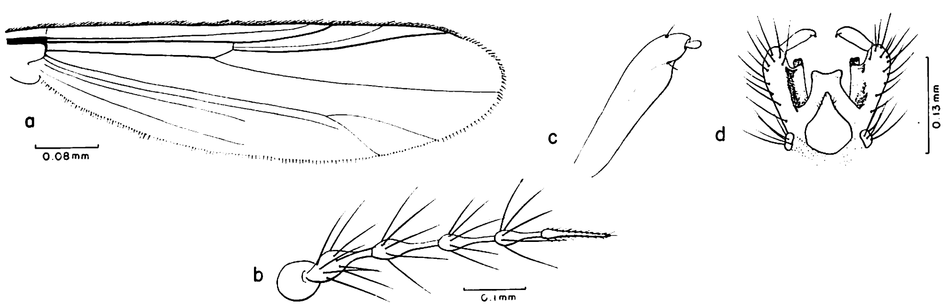

Figure 44—*Metriocnemus herbicolus* n.sp.: **a,** wing; **b,** female antenna; **c,** dististylus of male genitalia; **d,** male genitalia, ventral view.

FEMALE. The antennae are six-segmented, segments 3 to 5 have rather slender necks; these necks are approximately half as long as the remainder of the segment.

The apical segment is almost one-half longer than the penultimate (fig. 44b). The mesonotum is yellow with three brown vittae; the median vitta is broad and extends over the anterior half of the sclerite and the lateral vittae extend over the posterior three-fifths on the sides. The upper half of each pleuron is yellow. The wings are more distinctly brown fumose in reflected light than in the males. Otherwise females fit the description of the male except for smaller size.

Length: body and wings, 1.0 mm.

Holotype male and allotype female: Mt. Tantalus, Oahu, August, 1955, "swept from lush vegetation on side of trail" (D. E. Hardy). Seventy-eight paratypes (predominantly males: 6, same as type; 28, Poamoho Trail, Oahu, May, 1946 (W. W. Wirth), and May, 1953 (D. E. Hardy); 1, Pupukea, Oahu, Apr., 1952 (D. E. Hardy); 1, Kawailoa Trail, Oahu, 2,600 ft., Feb., 1952 (E. Dresner); 1, Kaluanui Valley, Oahu, May, 1946 (W. W. Wirth); and 41, Mt. Kaala, Oahu, 4,000 ft., Nov., 1946 (F. X. Williams), and July, 1946 (W. W. Wirth). Also a series of 12 or more specimens in alcohol from Mt. Kaala, 4,000 ft., Nov., 1945 (W. W. Wirth); not indicated as paratypes.

This species occurs in very humid regions in the mountains and is found on the vegetation along the trails. Williams reared it from moss collected on Mt. Olympus.

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. Remainder of paratypes in the following collections: U.S. National Museum, British Museum (Natural History), Hawaiian Sugar Planters' Association, and the University of Hawaii.

Subfamily CLUNIONINAE Kieffer

Clunioninae Kieffer, 1906, Ann. Soc. Bruxelles 30:314; 1906, Gen. Ins. 42:3. Edwards, 1928, Konowia 7:234; 1929 Trans. Ent. Soc. Lond. 77:370.
Clunionariae Kieffer, 1913, Rec. Ind. Mus. 9:121 (Group of Chironomidae).
Campontiinae Townes, 1945, Amer. Midland Naturalist 34:12.

Most of the members of this subfamily are marine midges. *Clunio vagans* Stone and Wirth may possibly be able to breed in both salt and fresh water. Only the genus *Telmatogeton* contains species which have adapted entirely to fresh water habitats. Some species of *Clunio* and *Telmatogeton* show a preference for areas along the sea coast where the ocean water is freshened by stream outlets. Exclusively fresh water species (*Telmatogeton*) are apparently known only from the Hawaiian Islands, and these live only in very swift mountain streams. The members are very different, structurally, from those of other subfamilies. The most striking distinctions are as follows: the pronotum is widely divided into lateral lobes; the anepisternal suture is very short or absent; the metanotum lacks a distinct median furrow or keel; the male antennae are nearly bare, never plumose, and consist of only 7 segments in *Telmatogeton* and *Thalassomya* and 11 segments in *Clunio*; the front is flat and developed rather platform-like above eyes and antennae (with a transverse fold above antennae); the eyes are round; vein R_{2+3} is absent; and the wings are distinctly gray, milky, or brown (in Hawaiian species). Also the details of the legs, genitalia, and habits differ considerably from

those of other subfamilies. Three genera occur in Hawaii: *Clunio* Haliday, *Thalassomya* Schiner, and *Telmatogeton* Schiner.

For a revision of the subfamily, including keys to genera of adults, larvae, and pupae, refer to Wirth (1949).

Genus **CLUNIO** Haliday

Clunio Haliday, 1855, Nat. Hist. Rev. 2:62.

The short, inconspicuous palpi, 11-segmented antennae of male, bare squamae, stout legs, short broad petiolated wings of male, absence of wings and halteres in female, and very large male genitalia will best differentiate this from other Clunioninae. The genitalia are at least as broad as the thorax and one-third as long as the abdomen. The females lack both wings and halteres (fig. 47e), the eyes contain about 15 small, widely separated facets, the legs are more reduced than in the males, and the antennae apparently contain but five segments in our species. In the male the basitarsi are one and one-half to three times longer than wide and two to three times longer than the second segment. The second to fourth segments are broader than long except on hind legs where third segment is about twice as long as broad and swollen dorsally. The fifth segment is cordiform and larger than the others. The wings are milky white by reflected light and smoky brown by transmitted light. In the female the first four tarsal segments are very short, much broader than long; the fifth segment is about as long as the preceding three. The tibial spurs are lacking. I see no practical way to separate the females of the Hawaiian species which have been studied.

A very thorough treatment of the genus has been given by Stone and Wirth (1947). They recorded three species from Hawaii and recently a fourth species has been collected.

Type of Genus: *Clunio marinus* Haliday.

Key to the Species of Clunio
(Modified from Stone and Wirth, 1947.)

1. Apical tibial spurs present on all legs, last antennal segment equal to at least five preceding segments; species 1.5–2.0 mm. in length 2

   Apical tibial spurs present only on hind legs; wings short, broad, and rounded (fig. 45b). Last antennal segment about equal to the preceding three (fig. 45a); tiny species, 1.0–1.2 mm. . . . . **brevis** Stone and Wirth.

2. Last antennal segment at least equal to or longer than preceding seven segments (fig. 47a). Vein R_1 short, less than half as long as Rs and less than two times longer than r–m (fig. 47b) 3

   Last antennal segment equal to the preceding four to five

segments. Vein R_1 about half as long as Rs and three times longer than r–m (fig. 46b)...... **littoralis** Stone and Wirth.

3. Last antennal segment slightly longer than the preceding nine segments (fig. 47a).......... **tsushimensis** Tokunaga.

   Last antennal segment about equal to the preceding seven segments (fig. 48a). Dististyli as in figure 48c.......... .... **vagans** Stone and Wirth.

Clunio brevis Stone and Wirth (figs. 45a–b).

Clunio brevis Stone and Wirth, 1947, Proc. Ent. Soc. Wash. 49:212.
Clunio sp. (Waimanalo) Williams, 1944, Proc. Haw. Ent. Soc. 12:171.

Endemic. Oahu (Type locality: Waimanalo).
Apparently confined to the rocky coast line of eastern Oahu.
Type in the U.S. National Museum.

This is the smallest of the Hawaiian species, and is distinguished by lacking spurs on the front and middle tibiae; by the very broad, short wings, and gently curved vein Cu_2 (fig. 45b); and the very short apical antennal segment (fig. 45a).

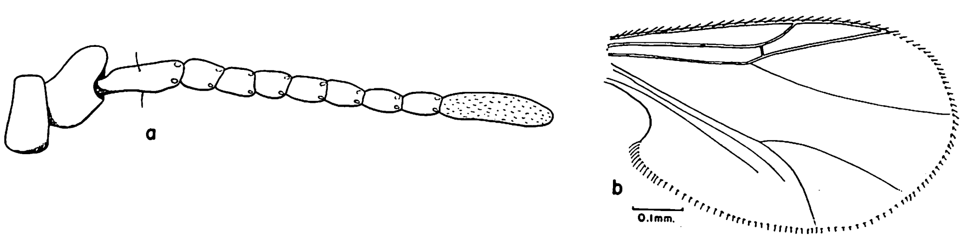

Figure 45—*Clunio brevis* Stone and Wirth: **a**, antenna; **b**, wing. (Copied from Stone and Wirth, 1947.)

MALE. Body chiefly brownish, flagellum of antenna, halteres, and most of legs yellowish white. Antennal segments proportioned as in figure 45a. Mesonotum with rather deep subdorsal furrows, each with three to five long, fine setae; also, three long fine setae in each supraalar area. Scutellum with about five setae, about equal in length to the scutellum. Wings as noted above and as in figure 45b. Vein R_1 is very short, not much longer than r–m crossvein. Genitalia as described by Stone and Wirth (1947: 213–214).

Length: body, 1.0–1.2 mm.; wings, 0.9 mm. long by 0.5 mm. wide.

FEMALE. Unknown.

This species has been taken only along the rough water, rocky coast of eastern Oahu. It occurs in the same habitats as *littoralis*. Wirth presumed that breeding occurred near the low-tide zone on the rocks covered with brown algae which are kept constantly drenched by the spray from heavy waves.

Clunio littoralis Stone and Wirth (figs. 46a–f).
Clunio littoralis Stone and Wirth, 1947, Proc. Ent. Soc. Wash. 49:203.

Endemic. Oahu (Type locality: Waimanalo), Hawaii, Kauai, and Midway(?). Type in the U.S. National Museum.

This species fits closest to *C. marinus* Haliday (from Europe) and *aquilonius* Tokunaga (from Japan) but is differentiated by the more elongate vein R_1 which is over two-thirds the length of R_{4+5}.

Clunio littoralis appears to be the most widespread of the Hawaiian species. It is collected running about on the rocks exposed to the tides and in light traps along the sea coast (Wirth has taken specimens two miles inland at light). The immature stages have not been discovered, but they apparently breed in the algae on the rocks.

This is differentiated from other Hawaiian species by having spurs developed on all the tibiae, the last antennal segment is equal to preceding four to five, and vein R_1 is rather elongate. Specimens are predominantly brown; the flagellum of antennae, halteres, most of legs, scutellum, and venter of abdomen are milky yellowish white. Wings white; eyes and tarsal claws black. The first flagellar segment is nearly five times longer than wide (fig. 46a). The mesonotum is bare

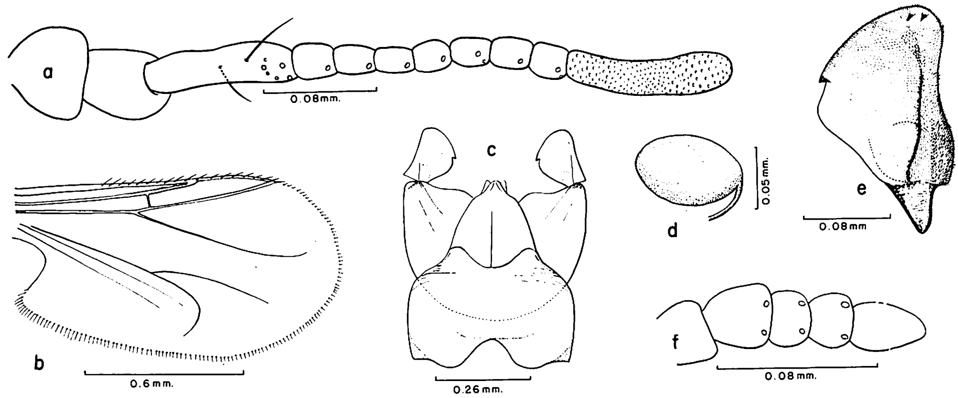

Figure 46—*Clunio littoralis* Stone and Wirth: **a,** antenna; **b,** wing; **c,** male genitalia, dorsal view; **d,** spermatheca; **e,** dististylus of male genitalia; **f,** female antenna.

except for seven to eight small setae in each dorsocentral row and about four in each supraalar area. Scutellum with about 14 short hairs, the longest about half the length of the scutellum. Wings as in figure 46b. Tibial spurs all strongly curved apically, those on hind legs the strongest. The basitarsi are about three times as long as broad on all legs. The genitalia are very similar to those of the other Hawaiian species with slight differences in the shapes of the dististyli (fig. 46c) and of the structures of the phallosome as described and figured by Stone and Wirth.

Length: body, 2.0 mm.; wings, 1.4 mm. long by 0.7 mm. wide.

FEMALE. Apparently much like the females of *vagans*, differing by having the cerci trapizoidal in outline, broader than long rather than triangular, and the ducts of the spermathecae more sclerotized and about one-half the length of the spermathecae (fig. 46d).

Length: body, 1.9 mm.

Clunio tsushimensis Tokunaga (figs. 47a–e).

Clunio tsushimensis Tokunaga, 1933, Phil. Jour. Sci. 51:92.

Clunio sp. (Hanauma Bay) Williams, 1944, Proc. Haw. Ent. Soc. 12:171.

Clunio tsushimensis Tokunaga, Hardy, 1956, Proc. Haw. Ent. Soc. 16:15.

Oahu. Distributed generally from the Honolulu Airport to Hanauma Bay. The earliest collection record is March, 1923, "Quarantine Island, S. C. Ball."

Immigrant. Previously known only from Japan.

Type in the collection at Kyushu University, Japan.

The specimens at hand apparently belong to *tsushimensis*. They fit in all details except that vein Cu_2 is not recurved, as shown in Tokunaga's figure 2. I suspect, however, that this is a variable character. I have sent specimens to Tokunaga and he confirmed that they were the same as *Clunio tsushimensis*. Our specimens best fit Tokunaga's var. *minor* since the ultimate antennal segment is approximately equal to the preceding nine segments, rather than slightly shorter than the preceding nine. This character does not appear to be of any importance and I see no advantage in calling our species var. *minor*.

This species is distinguished from other *Clunio* by the elongate apical segment of the antenna. It is the only species for the entire world which has the apical segment about equal to the remainder of the flagellum. It is closest to *vagans* Stone and Wirth and to *pacificus* Edwards. It also differs from other Hawaiian species by having a very poorly developed scape and segments 4 to 10 wider than long (fig. 47a). Tokunaga (1933:92 and fig. 7) says and shows that the scape of *tsushimensis* is longer than its diameter. It is not developed this way in the Hawaiian specimens.

MALE. Head is small and round, mouth parts atrophied. Palpi two-segmented. Eyes oval, thickly pubescent; at narrowest point eyes are separated by width equal to three times the basal antennal segment. Antennae 11-segmented, apical segments slightly longer than preceding nine. The scape is reduced to just a narrow ring and segments 4 to 10 are about two times wider than long (fig. 47a). (Note that the scape is apparently better developed in specimens from Japan, according to Tokunaga, figure 7.) Thorax is yellow-brown to slightly blackish, somewhat greenish tinged in living specimens and covered with gray pollen. Scutellum yellow-white, halteres white. Legs are largely yellow, each tibia with a strong slightly curved spur at tip. Pulvilli lacking, empodium as large as claws. Wings are milky white in reflected light; broad, anal angle well developed; squamae bare. Vein R_1 about one-half the length of Rs. The latter is about two-thirds as long as base of M. Vein Cu_2 strongly curved downward (fig. 47b) (recurved in specimens from Japan). Abdomen is brown to blackish in ground color, largely gray pollinose; narrow hind margins of segments black. Genitalia very

large, dististyli rather triangular, one-half longer than wide with several minute teeth on the caudal corner and a small tooth near the median portion of the inner margin (fig. 47d).

Length: body, 1.0–1.3 mm.; wings, 0.9–1.0 mm.

FEMALE. Eyes very small, consisting of about 10 facets (fig. 47e). Antennae apparently six-segmented, last segment about one-third longer than the penultimate. Spermathecae ducts not sclerotized, difficult to differentiate (fig. 47c.)

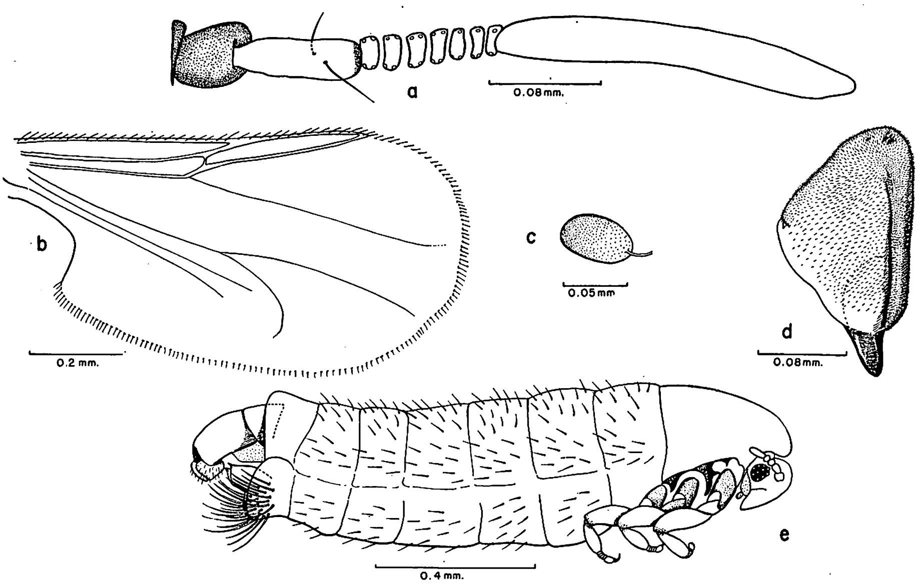

Figure 47—*Clunio tsushimensis* Tokunaga: **a,** antenna; **b,** wing; **c,** spermatheca; **d,** dististylus of male genitalia; **e,** lateral view of adult female.

Clunio vagans Stone and Wirth (figs. 48a–d).

Clunio vagans Stone and Wirth, 1947, Proc. Ent. Soc. Wash. 49:206.

Endemic. Kauai (Type locality: Wailua Falls), Oahu, and Hawaii.

Type in U.S. National Museum.

Related to *C. pacificus* Edwards (from Samoa, Japan, Ryukyu Islands, and Marianas) and differentiated by having vein Cu_2 distinctly curved and hind tibial spur slightly curved at tip. Of the other species known from Hawaii it fits closest to *tsushimensis* Tokunaga, but the apical antennal segment is shorter, about equal to the preceding seven segments (fig. 48a), not slightly longer than remainder of flagellum.

MALE. Predominantly brown; halteres, scutellum, and most of legs yellowish white; scape of antenna brown; third and last segments whitish, intermediate segments infuscated. Antennal segments proportioned as in figure 48a. Mesonotum

bare except for three small setae in dorsocentral rows and about five in each supraalar area. Scutellum with 12 short hairs, the longest about half the length of scutellum. Wings as in figure 48b. Vein R_1 short, about half as long as R_{4+5} and less than two times longer than r–m; vein Cu_2 sharply bent downward on apical half. The tibial spurs are all moderately curved apically. The basitarsi are about twice as long as broad on all legs. Genitalia are as shown in figures 48c-d and described by Stone and Wirth (1947:207–208). The diststyli are slightly concave on outer margins.

Length: body, 1.5–2.0 mm.; wings, 1.5 long by 0.7 mm. wide.

FEMALE. Similar to *littoralis* except that the cerci are triangular and bluntly pointed apically. Also the ducts of the spermathecae are lightly sclerotized for a distance equal to about one-third the length of the spermatheca.

Length: 1.5–2.0 mm.

For description of immature stages and biology refer to Stone and Wirth (1947:208–212).

This species apparently is able to adjust to fresh water habitats. Wirth found the adults at Wailua Falls, Kauai, but no breeding was observed. The falls are located about four miles from the sea, about one mile above the section of the river affected by tidal action. Its usual habitat is apparently the algae growths near the high-tide levels on the sea coast, probably in areas which receive a considerable proportion of fresh water.

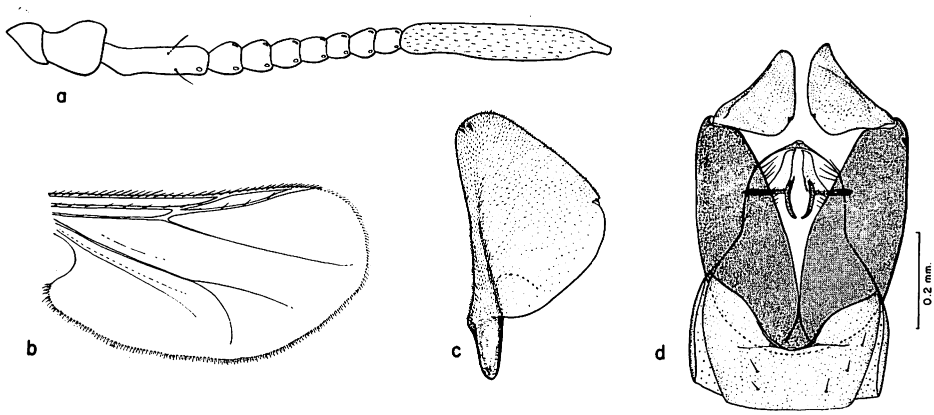

Figure 48—*Clunio vagans* Stone and Wirth: **a,** antenna; **b,** wing; **c,** diststylus of male genitalia; **d,** male genitalia, ventral view.

Genus **TELMATOGETON** Schiner

Telmatogeton Schiner, 1866, Verh. Zool.-Bot. Ges. Wien 16:931.
Charadromyia Terry, 1913, Proc. Haw. Ent. Soc. 2:292.
Trissoclunio Kieffer, 1920, Ann. S. Afr. Mus. 17:523.

The members of the genus *Telmatogeton* are distinguished from other Hawaiian

chironomids by having the fifth tarsal segment deeply trilobed (fig. 50c) and by having the female ovipositor conspicuously pointed. Also the very dark fumose, brown to grayish black wings are characteristic. The antennae are seven-segmented, non-plumose in both sexes. The head is small, set under the anterior margin of the arched mesonotum; the palpi are two-segmented.

For more complete description of the genus, also for characters of the larvae, pupae, and biology of the group, see Wirth (1947c:145).

The group was first recorded for Hawaii by Terry (1913) when he founded the genus *Charadromyia* for the species *torrenticola* and *abnormis*.

Schiner's description of the adult of *Telmatogeton* was incorrect and evidently accounted for Terry's mistake in considering these species as representing a distinct genus. Illingworth (1931b) recorded *Charadromyia torrenticola* from the Waiahole Ditch. Williams (1944:166–169) in his biological notes on Hawaiian chironomids gave notes on habits and life histories (with figures) of *T. pusillum* Edwards (= *pacificus* Tokunaga), *abnormis* (Terry), and *torrenticola* (Terry), plus two unnamed fresh water species from Oahu and Kauai. Wirth (1947c), monographed the group, reviewed all of the known biological information, and presented keys to the known species of adults, larvae, and pupae. Fifteen species are known for the entire world, seven of which occur in Hawaii. Our fauna is unique in that we have the only known species which live exclusively in fresh water; all other are marine (living along the sea coast). Five of our species are found in the swift-running, clear-water streams coming out of the mountains. Wirth said the adaptation to rapid water habitats is no doubt "due to an exceptionally acute demand by the immature stages for a combination of at least three factors: 1) high aeration, 2) constant moisture, and 3) freedom from waste materials. These factors are also met by the habitats on the spray-drenched coastal rocks selected by the marine species throughout the world." The adults of our fresh water species are usually found at falls and rapids in the mountain streams, running about on the rocks just barely above the water line where they are constantly being drenched with spray and are often washed downstream by the splashing water. It is nearly impossible to collect them in a net in this situation without the net getting soaked. The best method I have found for collecting them is to aspirate them off the rocks, but care must be taken to avoid sucking water into the tube. The adults are often seen to escape into the water to be washed downstream until they are able to crawl out onto another rock. They are extremely water repellent and after being submerged in water they come up perfectly dry; this is no doubt due to the dense covering of non-wettable microscopic pile over the body and wings. The adults of the fresh water species are more markedly diurnal than are other known *Telmatogeton*. They are active during the day, even in bright sunshine. It is probable that the nights are too cool for nocturnal activity in the mountain regions where most of the species occur. Our seacoast species are predominantly nocturnal and usually do not become active until dusk or on heavily overcast days.

Type of genus: *Telmatogeton sancti-pauli* Schiner.

KEY TO KNOWN HAWAIIAN SPECIES OF TELMATOGETON SCHINER
(From Wirth, 1947c:187)

1. Tarsal claws simple, not bifid (fig. 50c) 2
Tarsal claws bifid, each divided into a pectinate lateral arm and a sharp-pointed inner arm (fig. 49b) 3

2(1). Hairy vestiture of entire body, especially legs, very dense; legs of male with hairs 2 to 6 times as long as diameter of tarsus. Large species, body 8.0 to 10.0 mm., wings 7.0 to 8.0 mm. (Kauai) . . . . **hirtus** Wirth.
Vestiture normal, hair short. Smaller species, body 6.0 mm., wing 4.5 mm. (Hawaii, Molokai, Maui) . . . . **torrenticola** (Terry).

3(1). Claws asymmetrical, anterior and posterior claw of each leg dissimilar (fig. 50g) 5
Claws symmetrical, anterior and posterior claws similar (fig. 49f) 4

4(3). Claws with pectinate arm much longer than sharp inner arm (marine species) . . . . **pacificus** Tokunaga.
Claws with pectinate arm much shorter than inner arm (fig. 49f) (fresh water, on Oahu) . . . . . . **fluviatilis** Wirth.

5(3). Anterior claws with pectinate arm at least a third as long as the sharp inner arm 6
Anterior claws with pectinate arm reduced to a basal knob, posterior claws with sharp inner arms small, arising three-fourths way on the side of prominent pectinate arm (fig. 50g) (Oahu) . . . . **williamsi** Wirth.

6(5). Color brownish, median mesonotum stripes blackish, sides pale brown; 20 to 25 setae on radius (marine) . . . . **japonicus** Tokunaga.
Color mostly black, light brown markings on mesonotum confined to small humeral area; 7 to 10 setae on radius (fresh water) . . . . **abnormis** (Terry).

Telmatogeton abnormis (Terry) (figs. 49a–d).
Charadromyia abnormis Terry, 1913, Proc. Haw. Ent. Soc. 2:295.
Telmatogeton abnorme Edwards, 1928, Konowia 7:236.
Telmatogeton abnormis (Terry), Williams, 1944, Proc. Haw. Ent. Soc. 12:168.

Endemic. Kauai (Type locality: Kilauea) and Oahu. This species occurs in association with *T. hirtus* Wirth on Kauai.

Type in the B. P. Bishop Museum.

Wirth says, "It is believed *T. abnormis* is the ancestral form of fresh-water *Telmatogeton*; it is very close to the marine *japonicus* from which it probably was

derived; in turn the Oahu species *fluviatilis* and *williamsi* differ but slightly from *abnormis*, while *torrenticola* and *hirtus* are further removed."

This species fits close to *japonicus* Tokunaga, differing by its fresh-water habits, by its chiefly black coloration and darker fumose wings, and by having just 7 to 10 setae situated on the radius rather than 25 to 30. Also, vein R_1 is more elongate, extending about three-fourths the length of R_{4+5} rather than less than half the length of this vein. The species has been redescribed in detail by Wirth (1947c: 167–171), including descriptions of larvae and pupae.

Antennae as in figure 49a. Base of r-m crossvein situated slightly below middle of wing; fork of cubitus at level of base of r-m. Claws asymmetrical (fig. 49b), "unevenly bifid, with a sharp inner arm and a pectinate outer arm; on the anterior claws of all legs the sharp inner arm arises about half way on the side of the pectinate arm, the distal portions of the two being subequal in length; on the posterior claws the pectinate arm arises near the base of the inner arm and is only about half as long as the latter." Male genitalia with stout basistyli "nearly as broad as long, tapering distally, concave dorso-mesally, with sparse short hairs laterally and fine setae mesally; diststyles flattened, ovoid, about twice as long as broad, folded mesad, and covered with fine setae which are directed proximad on the flexor surface." (See figures 49c–d.)

Length: body, 4.5–5.0 mm.; wings, 3.0 mm. long by 1.0 mm. wide.

FEMALE. Similar to the male except for sexual differences; tarsal claws long and simple; eighth abdominal segment reduced, about as long as high, triangular in shape.

Telmatogeton fluviatilis Wirth (figs. 49e–f).

Charadromyia torrenticola Illingworth, *nec*. Terry, 1931, Proc. Haw. Ent. Soc. 7:408.

Telmatogeton sp. #1 (in part) Williams, 1944, Proc. Haw. Ent. Soc. 12:168.

Telmatogeton fluviatilis Wirth, 1947, Proc. Haw. Ent. Soc. 13:166.

Endemic. Oahu (Type locality: Waiahole Ditch, Kipapa). Apparently restricted to the fresh-water streams of the Koolau Mountains, Oahu.

Type in the U.S. National Museum.

Fitting close to *T. williamsi* Wirth and distinguished by the shape of the male tarsal claws and the long, narrow apical antennal segment. The claws of the male tarsi are alike on all legs, "deeply bifid into a long, sharp inner arm and a slender pectinate outer arm about two-thirds as long as inner" (fig. 49f). The last antennal segment is elongate and narrowly tapered at tip, is about four times longer than preceding segment and nearly equal to the preceding four segments (fig. 49e). The wings are more slender than those of *williamsi* and the fork of Cu is slightly below the r–m crossvein rather than slightly beyond it.

Length: body, 3.5–5.0 mm.; wings, 2.5–3.5 mm. long by 0.8–1.0 mm. wide.

The larvae and pupae were described by Wirth (1947:167).

Telmatogeton hirtus Wirth (figs. 49g–h).

Telmatogeton hirtus Wirth, 1947, Proc. Haw. Ent. Soc. 13:158.

Endemic. Kauai (Type locality: Wainiha Stream).

This has been taken only in swift mountain streams on Kauai, and is probably the species reported by Needham (1950) as "Telmatogeton torrenticola".

Type in the U.S. National Museum.

This is the largest species known in the genus for the entire world and is the largest midge known from Hawaii. It is distinguished by its large size, the remarkably hairy vestiture of the body, and the simple claws of the male.

MALE. Antennae as in figure 49g. Apical segment just slightly longer than segments 4 to 6 and tapered gradually on apical half. (Note: Sometimes only six antennal segments are present.) Entire antenna densely pubescent and with numerous sensory pits. Wirth says, "The most conspicuous feature of the entire insect is the marked elongation of the body hairs, most of these being as long as two to three times the diameter of the tarsi, and wavy toward the tip, giving the insect a remarkable "fuzzy" appearance." Mesonotum large, strongly and narrowly arched in front and overhanging the head. Scutellum densely haired with 50 or more long, fine hairs on disc. Crossvein r–m situated slightly before middle of wing. R_1 enters costa just before the middle of R_{4+5}. Vein M rather sinuate. Fork of cubitus at level of base of r–m crossvein. Cu_1 gently curved and Cu_2 short and strongly curved downward. Legs densely hairy, hairs very long and wavy. Apical tibial spurs single on all legs; also a pair of small ventral spines at tip of each of the basal four tarsal segment of each leg. Last tarsal segment deeply trilobed, claws (fig. 49h) simple, rather elongate, two times as long as median lobe of tarsus. Male basistyli stout, nearly as broad as long. "Slightly concave dorso-mesally, densely clad with course setae on lateral surface, fine setae mesally, diststyles sausage-shaped, slender, about three times as long as broad, scarcely tapering distad with rounded tips, folded mesad and clad with fine setae which are directed proximad on the flexor surface." (Wirth, 1947c)

FEMALE. Similar to male but not so conspiculusly hairy.

Length: body, 8.0–10.0 mm.; wings, 7.0–8.0 mm. long by 2.0 mm. wide.

For descriptions of larvae and pupae see Wirth (1947:159–161).

Telmatogeton japonicus Tokunaga (figs. 49i–j).

Telmatogeton japonicus Tokunaga, 1933, Phil. Jour. Sci. 51:95.

Hawaii (taken only on wave-drenched boulders at Hilo Bay and in light trap at Hilo).

Immigrant. Known previously only from Japan.

Type in the collection at Kyushu University, Japan.

Very similar to the fresh water *T. williamsi* Wirth but brownish in color with 20–25 setae on radius and with vein R_1 short, extending less than half the length of R_{4+5}.

This has been redescribed in detail by Wirth (1947c:171–175), including larvae and pupae. Tokunaga (1933) also gave a good description and an excellent detailed account of its biology and habits.

Antenna very close to that of *williamsi* (fig. 49i). The base of the r–m crossvein is situated before the middle of the wing. The fork of cubitus is slightly beyond

the base of r–m. The following quotations are from Wirth (1947c:172). "Tarsal claws alike on all legs, unevenly bifid; the anterior claws of each leg bifid at distal three-fourths with the pectinate outer process about twice the length of the sharp inner process; the posterior claws bifid at proximal third, the pectinate lateral process about half the length of the long, sharp inner process. Each claw with a lanceolate hyaline lamella arising mesad at base." (Fig. 49j) Male genitalia with stout basistyli "truncated, with a small setigerous lobe on mesal side near base, with long setae ventro-laterally becoming very small and fine on dorso-mesal surface; dististyles oval, flattened, with fine setae, these directed proximad on flexor surface."

Length: body, 3.0–4.0 mm.; wings, 2.5–3.5 mm. long by 0.6–0.8 mm. wide.

FEMALE. With broader wings than male, all tarsal claws simple; eighth abdominal segment triangular and about one-half longer than high.

Telmatogeton pacificus Tokunaga (figs. 49k–m).

Telmatogeton pacificus Tokunaga, 1935, Mushi 8:15.

Telmatogeton pusillum Williams (*nec.* Edwards), 1944, Proc. Haw. Ent. Soc. 12:166.

Oahu, Kauai, Hawaii; probably generally distributed on the rocky seacoasts of all the Hawaiian Islands.

Immigrant. Japan.

Type in the collection at Kyushu University, Japan.

This fits in the group of species which have the male claws bifid and symmetrical, anterior and posterior claws on each leg similar, and the pectinate arm much longer than the sharp inner arm (fig. 49k). It is closest to *T. pusillum* Edwards (Marquesas Islands), but the empodium is bifid at tip (fig. 49k) and vein Cu_2 is only gently curved. In *pusillum* the empodium is simple and vein Cu_2 is sharply bent and recurved. As pointed out by Wirth (1947c:181), the records of *pusillum* from Hawaii should refer to *T. pacificus;* the former is known only from the Marquesas Islands. For a complete redescription of the species, including the larvae and pupae, see Wirth (1947c:176–181). For notes on the breeding habits see Williams (1944:166) under the name *T. pusillum.*

This is the smallest species of *Telmatogeton* in Hawaii. The specimens are predominantly brown with grayish pruinescence on the mesonotum. The antennae are shaped much as in *japonicus*; the apical segment is rather short, about two times longer than wide, and about equal to the two preceding segments (fig. 49l). The lobes of the pronotum each have just a single seta. There are 7 to 10 long, black setae in each dorsocentral row and 3 to 6 in each supraalar group. The scutellum has about 10 long setae, the longest is about equal to the length of the scutellum. The wings are grayish brown; the r–m crossvein is situated at about the basal two-fifths of the wing; the fork of cubitus is well beyond the r–m crossvein, about opposite the middle of vein R_1. The anal angle is rather acute, generally about 90 degrees. Vein Cu_2 is rather strongly curved downward. Legs elongate,

the last tarsal segment trilobed, "the lobes relatively short, especially the lateral pair which are scarcely perceptible. Tarsal claws alike on all legs, symmetrical, bifid at basal third, lateral tooth long and rounded pectinate at tip, inner tooth about half as long, slender and sharp" (fig. 49k). Abdomen sparsely setulose, basistyli of male genitalia rather slender, widely separated at bases by the aedeagus and accessory structures, and without a lobe at base of dorsomesal surface. "Diststyles short, oval, flattened, thickly covered with fine curved setae." (fig. 49m). The above quotations are from Wirth (1947c:178).

Length: body, 2.0–3.0 mm.; wings, 1.2–2.0 mm. long by 0.4 to 0.6 mm. wide.

FEMALE. Similar to male except the wings are shorter, not extending to the tip of the abdomen. The tarsal claws are long and slender, simple and pointed. The eighth abdominal segment is much narrower and produced. The cerci are elongate and slender.

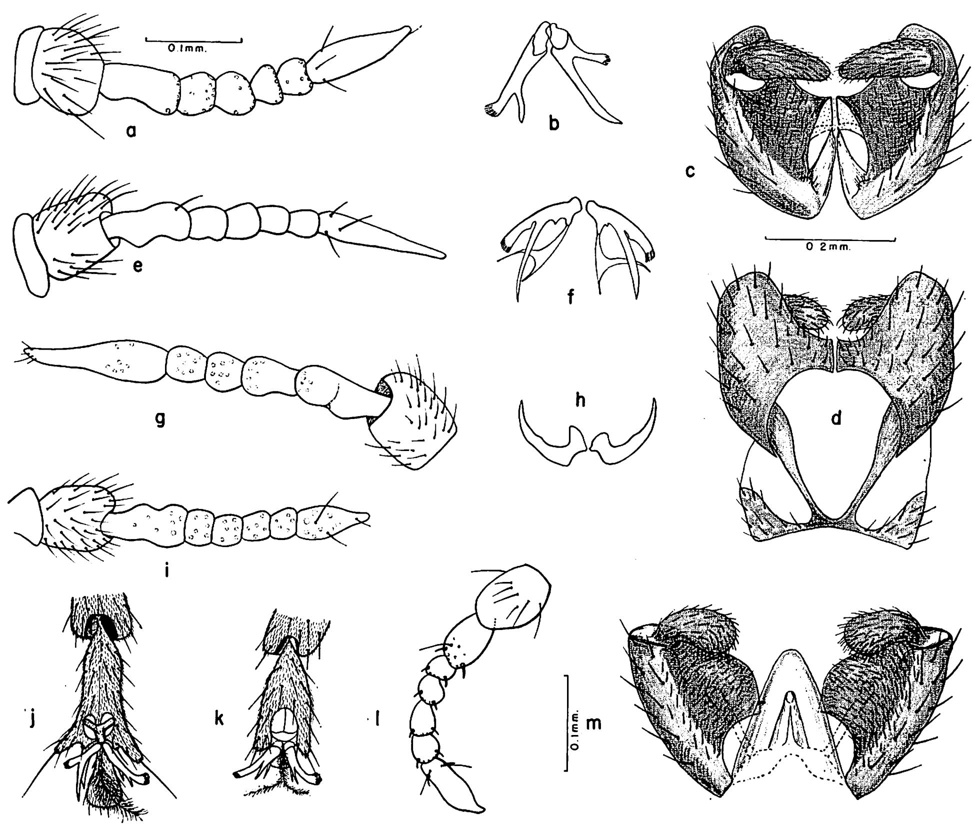

Figure 49—*Telmatogeton abnormis* (Terry): **a,** antenna; **b,** tarsal claws; **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view. *T. fluviatilis* Wirth: **e,** antenna; **f,** tarsal claws. *T. hirtus* Wirth: **g,** antenna; **h,** tarsal claws. *T. japonicus* Tokunaga: **i,** antenna; **j,** apex of tarsus, ventral view. *T. pacificus* Tokunaga: **k,** apex of tarsus, ventral view; **l,** antenna; **m,** male genitalia, dorsal view. (Figures **b, e, f, g, h, i,** and **j** copied from Wirth, 1947.)

Telmatogeton torrenticola (Terry) (figs. 50a–e).

Charadromyia torrenticola Terry, 1913, Proc. Haw. Ent. Soc. 2:292.

Telmatogeton torrenticola (Terry), Edwards, 1928, Konowia 7:236.

Endemic. Maui (Type locality: Nahiku), Hawaii, and Molokai.

Type in the B. P. Bishop Museum.

This is apparently the only fresh-water species found on the islands of Hawaii, Maui, and Molokai. It is common on the rocks in the streams flowing out of the mountains. It is distinguished from other Hawaiian species by the large size, the large simple claws of the male (fig. 50c), and by the reduced hairy vestiture of the body.

MALE. The antennae are proportioned as in figure 50b. The apical segment is approximately equal to segments 3 to 6, inclusive. The lobes of the pronotum each have three to five setae; four to five small setae are situated in each dorsocentral row and four or five long setae are in each supraalar group. The scutellum has about 30 long, black hairs; the longest not as long as scutellum. The wings are opaque, dark brownish black. The costa is thickly covered with small spines, these becoming smaller toward wing tip. Radial vein setulose, other veins bare. Crossvein r–m situated near middle of wing, and fork of cubitus at about level of base of r–m. Vein Cu_2 strongly curved downward (fig. 50a). Leg segments slender, last tarsal segment deeply trilobed; middle lobe extending to tip of claws; the lateral lobes are about three-fourths as long as claws. All claws long and sharp, not at all bifid. Abdomen sparsely covered with very fine setae. Genitalia as in figures 50d–e and as described by Wirth (1947c:156).

Length: body, 6.0 mm.; wings, 4.5 mm. long by 1.3 mm. wide.

FEMALE. Similar to male but slightly larger in size, wings not reaching tip of abdomen and the legs slightly shorter.

For more complete details of adults see Wirth (1947c:155). The immature stages were described by Terry (1913:294).

Telmatogeton williamsi Wirth (figs. 50f–k).

Telmatogeton williamsi Wirth, 1947, Proc. Haw. Ent. Soc. 13:162.

Telmatogeton sp. #1 (in part) Williams, 1944, Proc. Haw. Ent. Soc. 12:168.

Endemic. Oahu (Type locality: Waianae—"taken from rock lined ditch which receives swift flowing water from Mt. Kaala").

Distinguished from other Hawaiian species by the development of the male tarsal claws; these are asymmetrical, the anterior and posterior claws are dissimilar on each leg; the anterior claws have a pectinate arm reduced to a basal knob, and the posterior claws have a small, sharp inner arm arising at the apical three-fourths of pectinate arm (fig. 50g).

MALE. A moderate-sized species fitting the general characteristics of the group except for the details of the tarsal claws given above. The antennae are as in figure 50f. Wirth described the genitalia as follows: "Basistyles stout, strongly setigerous ventro-laterally and fine setae on dorso-mesal surface, with a small dark finely setigerous lobe on dorso-mesal side near base; dististyles oval, flattened,

concave ventrally, folded mesad, with fine setae, these directed proximad on flexor surface." (See figures 50j–k.)

Length: body, 3.0–5.0 mm.; wings, 3.0 mm. long by 1.0 mm. wide.

FEMALE. Similar to the male, slightly larger, and with all tarsal claws long, pointed, simple, not bifid. Wing broader than in male and not extending to tip of abdomen.

Length: body, 4.0–6.0 mm.; wings, 3.0–4.0 mm.

For a detailed description of the larva and pupa refer to Wirth (1947c:163–165).

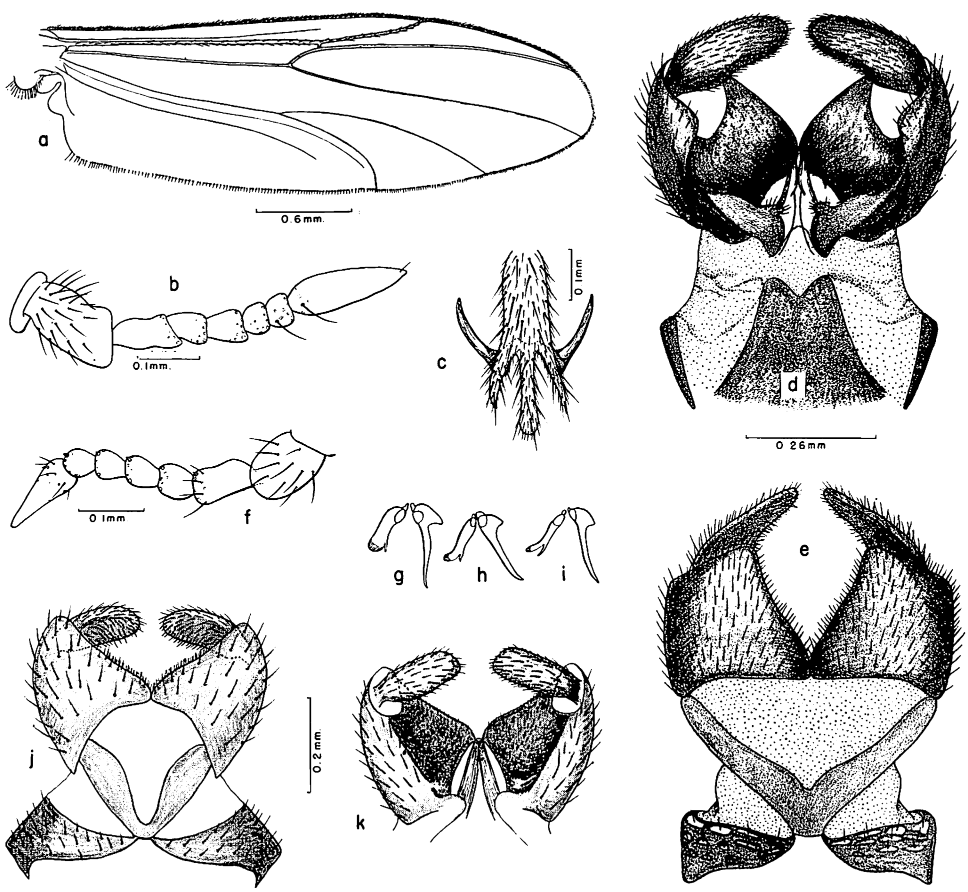

Figure 50—*Telmatogeton torrenticola* (Terry): **a,** wing; **b,** antenna; **c,** apex of tarsus, dorsal view; **d,** male genitalia, dorsal view; **e,** male genitalia: ventral view. *T. williamsi* Wirth: **f,** antenna; **g,** front tarsal claws; **h,** middle tarsal claws; **i,** hind tarsal claws; **j,** male genitalia, ventral view; **k,** male genitalia, dorsal view. (Figures **g, h,** and **i** copied from Wirth, 1947.)

Genus **THALASSOMYA** Schiner

Campontia Johnston, 1830, Zool. Jour. 3:325 (described from larva as an annelid worm but was probably a marine insect; some workers considered it a *Thalassomya* sp.?).

Thalassomya Schiner, 1856, Verh. Zool.-Bot. Ges. Wien 6:218.
Thalassomyia Schiner, 1868, Novara Reise, Zool. 2:24 (an emendation).
Scopelodromus Chevrel, 1903, Arch. Zool. Exp. 1:1.
Galapagomyia Johnson, 1924, Zoologica 5:86.

The emended name *Thalassomyia* is still being used by some workers; see Freeman (1955:65).

Members of this genus are marine midges, usually found breeding in the intertidal zone along the shores where heavy growths of algae occur on the rocks.

Differentiated from other Clunioninae (in Hawaii) by the elongate four-segmented palpi, simple fifth tarsal segment, and by having the r–m crossvein and base of R_{4+5} situated near basal third of wing, well before fork of Cu (fig. 51a). The eyes are bare, the antennae have seven segments in both sexes; the apical segments are over two times longer than the penultimate and have a terminal nipple-like constriction (fig. 51b). The legs are long, especially the hind pair; the posterior tibiae each have two spurs at apices. The fourth segment of tarsus is cordiform; the third is bilobed at apex. Empodium very long, pectinately plumose. Anterior claws of front and middle tibiae of male pectinate.

The genus contains seven known species for the world; just one is present in Hawaii.

Type of genus: *Thalassomya frauenfeldi* Schiner.

For monographic studies of the genus (including descriptions of larvae and pupae), refer to Wirth (1947b; 1949).

Thalassomya setosipennis Wirth (figs. 51a–e).
Thalassomyia setosipennis Wirth, 1947, Proc. Haw. Ent. Soc. 13:121.

Endemic. Hawaii (Type locality: Hilo), Oahu, Maui, and Kauai.

Type in the U.S. National Museum.

This is a small, light brown species with yellowish white pronotal lobes, wing bases, scutellum, and halteres. The head is densely setulose. It is distinguished from other known *Thalassomya* by having the bases of veins M, Cu, and 1st A setulose (fig. 51a); the palpi (fig. 51d) nearly two times longer than antennae; the male dististyli not markedly swollen at bases (fig. 51c); and the female cerci slender (fig. 51e). In the other species only the costa and radius are setulose.

Length: body, 2.0–3.0 mm.; wings, 2.1 mm.

See Wirth (1947) for complete description of adults, larvae, and pupae; also for information on habits.

Wirth said, "The adults of *T. setosipennis* are quite active, hard to catch, much more inclined to flight, and stronger fliers than *Telmatogeton* and *Clunio*." Wirth indicated that all of his specimens were collected "from inter-tidal rocks along the shores of shallow bays receiving considerable fresh-water from stream outlets. Heavy growths of the algae *Ulva* sp. and *Enteromorpha* sp. were present on the rocks in each case, indicating perhaps that *Thalassomyia* prefers waters of less salinity than sea-water." I have, however, taken numerous specimens on the wall built as a breakwater in the yacht channel at Honolulu and on rocks at

Punaluu, and Mrs. Kohn has found the adults in abundance on the rocks at Diamond Head, all in areas where the water is not freshened by stream effluents; also it has been collected in a light trap at the Quarantine Station, Honolulu, and on the shore along the rocky coastline at Koko Head, Oahu.

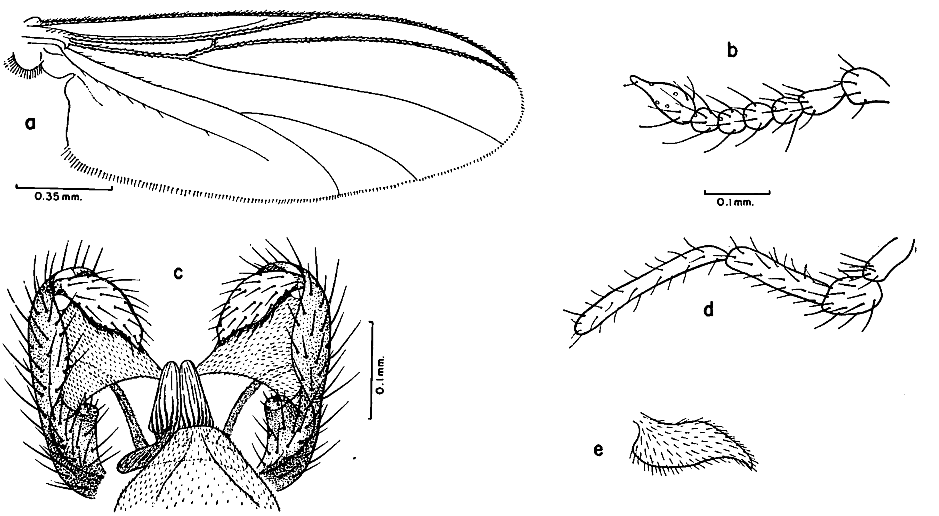

Figure 51—*Thalassomyia setosipennis* Wirth: **a,** wing; **b,** male antenna; **c,** male genitalia, dorsal view; **d,** palpus of male; **e,** cercus.

Family CERATOPOGONIDAE Newman
The Biting Midges

Ceratopogonites Newman, 1834, Ent. Mag.: 379.
Ceratopogonina Skuse, 1889, Proc. Linn. Soc. N.S. Wales 4:222.
Ceratopogoninae F. Lynch Arribalzaga, 1893, Bol. de la Acad. Nac. de Ciencias en Cordoba :220.
Stenoxenidae Coquillett, 1899, Ent. News 10:61.
Heleinae Speiser, 1910, in Sjostedt's, Wissenschaft. Ergebnisse der Schwedischen Zool. Exped. Kilimandjaro 2(10):198.
Ceratopogonidae Malloch, 1917, Bull. Ill. State Lab. Nat. Hist. 12:281.
Heleidae Hendel, 1928, Tierwelt. Deutschl., 2, Dipt. 2:68.

The name comes from the Greek keras, horn, and pogon, beard; referring to the very densely plumose (bearded) antennae of the males.

Rather small, predominantly dark colored, rather hairy flies, ranging in size from 0.9 mm. to 2.4 mm. in the Hawaiian fauna. The antennae are moderately slender, consisting of 15 segments in all of our known species (except in the females of *Forcipomyia* (*Trichohelea*), which have 11-segmented antennae). The scape is greatly reduced to a ring-like segment, very inconspicuous, and hidden by the enlarged pedicel so the antennae actually consist of 14 apparent segments, 10 in females of *F.* (*Trichohelea*). The ocelli are lacking. The mouthparts are well

developed, fitted for piercing and sucking, and enclosed in an elongate proboscis. These consist of a strong labrum, a pair of mandibles, a pair of maxillae, and a tubular hypopharynx. The palpi are five-segmented, although in the known Hawaiian species, except *Forcipomyia*, the first segment is fused with the head. The metanotum is short and rounded and has no longitudinal groove down the middle. The mesonotum is rather broad and convex above, somewhat arched but not projecting over the head. The wings are hairy in most of the Hawaiian species, sometimes densely so, and fold flat (one over the other) over the abdomen when at rest. The venation is characteristic in that the radial veins and the costa end near the middle of the wing (fig. 53e). The legs are rather short and stout; the ratio of the tarsal segments is useful in classification. The empodium is well developed in species of *Forcipomyia* and *F.* (*Trichohelea*) (except the males) and is vestigial or lacking in *Dasyhelea*. The genitalia are rather simple, the ninth tergum is large; the diststyli are simple, slender, and incurved. The aedeagus and its supporting structures are variously modified and are important characters for separating species.

These flies are related to the Chironomidae but are separated by the short metanotum and by the lack of a metanotal groove; also the adults, when at rest, carry the wings folded one over the other on the back.

Our species are of no apparently economic importance. *Forcipomyia ingrami* Carter often becomes extremely abundant and sometimes swarms into houses, especially at night, and may become a nuisance. In other parts of the world, some of the Ceratopogonidae are very serious pests. The genera *Culicoides*, *Leptoconops*, and *Lasiohelea* are bloodsuckers (man and other animals), and some *Culicoides* transmit diseases of man in some parts of the world. Many species of *Forcipomyia* (not known for Hawaii) suck blood of other insects and are commonly collected attached to the wing bases of butterflies, Neuroptera, Odonata, mosquitoes, crane flies, etc. Some feed on Phasmidae, some on Phalangida spiders, and some feed on the larvae of butterflies and moths (see Wirth, 1956b and Knab, 1914). Several species of *Culicoides* play an important role in the transmission of filarial worms of man and other animals in Africa, Central and South America, Malaya, and probably other parts of the world. Some *Culicoides* have also been found to transmit pathogenic viruses to domestic animals. The blue tongue disease of sheep and horses in South Africa is transmitted by *Culicoides*, according to Du Toit (1944). Tokunaga (1937) reported that fowl pox was transmitted by *Culicoides sugimotonis* Shiraki in Formosa. This species breeds in poultry dung. Also, as pointed out by Wirth (1952:97), there is a possibility that *Culicoides* may assume a role in the transmission of avian parasites, as suggested by the findings of Jellison and Philip (1933). The blood-sucking species are very notorious wherever they occur in the world because of the extreme annoyance caused by their biting. The bites cause intense sharp pain and rather severe irritation. The biting midges are commonly called "punkies," "no-seeums," or sandflies in the southern United States. The latter is a misnomer since the common name "sand fly" should be reserved for *Phlebotomus* in the Psychodidae.

According to Johannsen (1937a:4), the larvae of Ceratopogonidae differ from

those of Chironomidae by being "vermiform, with neither anterior nor posterior prolegs, or, when both are present, the body segments variously adorned with spines and bristles, or the anterior proleg may be wholly lacking and the posterior one represented by a few claws at the apex of the body." Also refer to Thompsen (1937) and to Wirth and Stone (1956:424–437) for information on the immature stages.

Just two genera and one subgenus are known from Hawaii. These belong in two subfamilies.

Key to Subfamilies, Genera, and Subgenera of Ceratopogonidae in Hawaii

1. Antenna with a nipple-like apex (fig. 55a). Vein R_{4+5} meeting the costa at a slant, apex of second radial cell acute not square (fig. 53e). Eyes bare. Empodium well developed except in males of subgenus **Trichohelea.** Subfamily **Forcipomyiinae,** Genus **Forcipomyia** Kieffer 2

   Antenna not nipple-like at apex (fig. 57a). Vein R_{4+5} bent up sharply at a right angle at apex so that apex of second radial cell is square (fig. 56d). Eyes with short pubescence. Empodium vestigal or absent. . . . . Subfamily **Dasyheleinae,** Genus **Dasyhelea** Kieffer.

2. Hind basitarsus not over one-half longer than second in the female and about equal to second in the male. Empodium present in both sexes. Alula fringed. Second radial cell short in the male (one-half as long as distance from R_1 to r–m crossvein) (fig. 54d). Basistylar apodemes and parameres, if present, not forming an H-shaped structure (fig. 54c). Female antenna 15-segmented (8 short segments beyond first flagellar) 3

   Hind basitarsus equal to next three segments in both sexes. Empodium absent in the male. Second R elongate in both sexes (fig. 55d). Alula bare. Parameres joined by a crossbar forming with the basistylar apodemes a short H-shaped plate (fig. 55e). Female antenna (fig. 55b) 11-segmented (3 short segments in flagellum plus oblong first flagellar segment) . . . . **Forcipomyia (Trichohelea)** Goetghebuer.

3. The apodemes of the basistyli are joined in a square-topped arch and the parameres are fused at apices and terminate in a sharp point just before tip of aedeagus (fig. 52d). . . . . **Forcipomyia (Metaforcipomyia)** Saunders.

   Basistylar apodemes joined in the form of an arch but para-

meres not present (fig. 54c)............................
...............**Forcipomyia (Proforcipomyia)** Saunders.

Subfamily FORCIPOMYIINAE Lenz

Forcipomyinae Lenz, 1934, in Lindner's Der Fleigen der Pal. Reg. 13a:97.
Forcipomyiinae Wirth, 1952, Univ. Calif. Publ. Ent. 9:116.

Distinguished from other subfamilies by having the empodium well developed, at least in the female. According to Thompsen (1937:59) the larvae of this subfamily are distinguished from other ceratopogonids by having prolegs developed on the prothorax and by having short spines on all body segments and a double row of hooks on the anal segment.

Only one genus, *Forcipomyia* Kieffer, and three subgenera, *Trichohelea* Goetghebuer, *Proforcipomyia* Saunders, and *Metaforcipomyia* Saunders, occur in Hawaii.

Genus **FORCIPOMYIA** Meigen

Forcipomyia (Megerle Ms) Meigen, 1818, Syst. Beschr. Eur. Zweifl. Ins. 1:73.
Labidomyia Stephens, 1829, Cat. Brit. Ins. 2:239.
Tetraphora Philippi, 1865, Verh. Zool.-Bot. Ges. Wien 15:630.
Prohelea Kieffer, 1912, Spolia Zeylanica 8:1.
Euforcipomyia Malloch, 1915, Bull. Ill. State Lab. Nat. Hist. 11:312.
Lepidohelea Kieffer, 1917, Ann. Mus. Nat. Hung. 15:364.
Microhelea Kieffer, 1917, Ann. Mus. Nat. Hung. 15:364.
Apelma Kieffer, 1919 (not Billberg, 1820), Ann. Mus. Nat. Hung. 17:64.
Trichohelea Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg. 8:18.
Thyridomyia Saunders, 1925, Parasit. 17:268.
Phasmidohelea Mayer, 1937, Arb. Morph. Tax. Ent. Berl. Dahlem 4:233.
Proforcipomyia Saunders, 1956, Can. Jour. Zoo. 34:662.
Warmkea Saunders, 1956, Can. Jour. Zoo. 34:671.
Caloforcipomyia Saunders, 1956, Can. Jour. Zoo. 34:680.
Metaforcipomyia Saunders, 1956, Can. Jour. Zoo. 34:685.
Synthyridomyia Saunders, 1956, Can. Jour. Zoo. 34:688.
Williams (1944:173) used the misspelling *Forcypomyia*.

There has been much controversy in the literature concerning the author of *Forcipomyia*. In general usage the name has been attributed to Meigen (1818) and even though it was first published by Meigen as a rejected manuscript name proposed by Megerle, for the sake of uniformity, it is best to accept the name as of this date. I have petitioned the International Commission for Zoological Nomenclature to validate *Forcipomyia* Meigen, 1818, by placing it on the Official List of Generic Names in Zoology.

Rather stout bodied, very densely haired species, especially in male; the eyes are bare; the antennae are typically 15-segmented with a distinct nipple-like development at the apex of the last segment. The female of typical *Forcipomyia* has segments 11 to 15 cylindrical, three or more times longer than wide. The

male has segments 12 and 13 very long and slender, eight or more times longer than wide. Vein R_{4+5} curves gently up to costa so the apex of the second radial cell is acute. In typical *Forcipomyia* the empodium is well developed in both sexes and the alulae are fringed. Also the hind basitarsus is short compared to the second tarsal segment. The second radial cell is very short in the male (about one-half as long as the distance from vein R_1 to the r–m crossvein) and the parameres of the male genitalia are slender and tapering.

An excellent revision of this genus, based upon characters of all stages, has recently been published by L. G. Saunders (1956). According to his classification the known Hawaiian species apparently fit in the three different subgenera.

Saunders divides *Forcipomyia* into eight subgenera based upon development of the parameres of the male genitalia; on the development of the larval head, the larval prothoracic pseudopod, and the last larval segment; and on the development of the pupal respiratory horn (refer to Saunders, 1956:703, fig. 19).

According to Thompsen (1937:59) the larvae of *Forcipomyia* are differentiated from those of related groups by having the "body not flattened, circular in cross section; segments with processes less than half the length of the segment." Long (1902) found the larvae of *Forcipomyia* living in tree holes, in rotting bark, under cow dung, and in nests of foraging ants. Saunders (1956:658) said "The larvae feed chiefly on mold spores and hyphae and so occur in moist situations such as rotting wood and bark, hollow roots, and stems of dead plants, under horse and cow dung, in tree holes and the sap of tree wounds, in or above the water held in the leaf axils of plants, and in moss growing on wood, rocks, or soil."

Type of genus: *Ceratopgon ambiguus* Meigen (= *Tipula bipunctata* Linnaeus).

Key to Hawaiian Species of Forcipomyia (Excluding Subgenus Trichohelea)

1. Wings not spotted, legs not banded........................2

   Wings pale, with distinct brown spots. Legs yellow, banded with brown on tibiae and tarsi. Genitalia as in figure 52d, parameres fused at apices (fig. 52d)........................ **F. (Metaforcipomyia) fuscimaculata n. sp.**

2. Clasper (dististylus) with a submedian lobe on venter. Aedeagus indistinctly trilobed (fig. 54c)........................ **F. (Proforcipomyia) palikuensis n. sp.**

   No submedian lobe on clasper and aedeagus triangular, not trilobed (fig. 53b)....**F. (Proforcipomyia) ingrami Carter.**

Subgenus **METAFORCIPOMYIA** Saunders

Forcipomyia (*Metaforcipomyia*) Saunders, 1956, Can. Jour. Zoo. 34:685.

The only previously recorded species of this subgenus is characterized by having

the parameres of the male genitalia fused along the middle line and extending back to tip of aedeagus (see Saunders, 1956: 686, fig. 11k). One Hawaiian species is being tentatively placed here because the parameres are fused at the apices. I suspect that our species does not properly belong here, but until the immature stages have been studied I am unable to place it more accurately.

For a more complete diagnosis of the subgeneric characters of the adults, larvae and pupae see Saunders (1956).

Type of subgenus: *Forcipomyia* (*Metaforcipomyia*) *cerifera* Saunders.

Forcipomyia (Metaforcipomyia) fuscimaculata, new species (figs. 52a–d).

This is a very distinctly marked species apparently belonging to the subgenus *Metaforcipomyia* Saunders, and I have been unable to locate it in the literature. In Ingram and Macfie's (1924:541–546) key to African species of *Forcipomyia*, it will not run beyond couplet 31. It does not fit the characters of any of the included species. In Goetghebuer's (1933:7–9) key to Palearctic species, it runs to couplet 28, but does not fit any of the included species. In Wirth's key to the California species (1952:127) it runs to couplet 13, but is not related to any of the included species. It also will not run in Macfie's key to the *Forcipomyia* of Sumatra and Java (1934b:178). Dr. Wirth (U.S. National Museum) has indicated that this is close to *cinctipes* (Coquillett) from the southern United States and Mexico. It differs from this by lacking pale spots on the wings and by the different genitalia of the males. The ninth sternum is gently convex on the hind margin, not emarginate in middle; the parameres are fused at apices and the entire genitalia are very different from Wirth's figure of *cinctipes* (1952:129, fig. f.). The two species obviously belong to different subgenera. *F. fuscimaculata* seems to resemble *F. swezeyi* Edwards (1928b:50) from Samoa, but the legs are not covered with small, close lying scales (Kieffer's group *Lepidohelea*), the abdomen is not blackish, and the markings of the wings and legs differ from Edwards' description. This would differ from Saunders' diagnosis of *Metaforcipomyia* (1956:685) by not having the parameres fused all the way down the mid line (see Saunders: 686 fig. 11k).

F. fuscimaculata is readily separated from other Hawaiian species by its dark spotted wings, banded legs, and by the male genital characters (fig. 52d). It is probably an immigrant species.

MALE. *Head:* Brown with long black bristles on vertex and occiput and with some fine yellow hairs on the occiput. Antennae and palpi yellow tinged with brown. Antennae densely plumose, the plumes largely brown, becoming creamy at the apices. The eyes are broadly joined on the front, there is no space separating the facets of the two eyes. Scape of antenna inconspicuous, hidden by the large pedicel. Antennal segment 12 swollen at the base and rather long and slender, about one-third longer than segment 13. Segment 13 slightly enlarged at base and approximately one-third longer than segment 14. The apical segment has a distinct nipple-like projection at the tip and is just slightly longer than segment 14 (fig. 52a). The palpi are five-segmented; the third is swollen just below the middle

and has a moderate to large oval-shaped sensory structure. This segment is approximately one-third longer than R_{4+5}. The last two segments are about equal in length (see fig. 52b of the female). *Thorax:* Largely brown, gray pollinose, marked with yellow on the humeri and the pleura. Mesonotum with fine yellow hairs on the anterior half and longer black bristles on the posterior half (with a few yellow hairs intermixed). The scutellum has about ten strong bristles on the hind margin; the longest of these are about three times longer than the scutellum. Halteres entirely white. *Legs:* Largely yellow, the femora are indistinctly brown just before the apices. Each tibia has a rather broad brown ring near base and another just beyond the middle. The tarsi are broadly ringed with brown on the basal three-fourths of each segment; these rings are much more distinct on the basal two to three segments. The legs are rather thickly covered with long yellow and brown bristles and no scales are present. The basitarsus of the front leg is nearly one-third longer than the second segment. On the middle leg the second segment is one-third longer than the first, and on the hind leg the second is about one-fourth longer than the first. *Wings:* Marked with several brown to black spots but with no yellow or whitish spots. The spots are made up of brown to black macrochaetae, in contrast to the paler colored hairs over most of the surface of the wing. The hairs comprising the spots are slightly more flattened and scale-like than the other hairs. A spot is present in the basal third of the wing just before the r–m crossvein, extending across cells R and M. Another is present in cell R_5 just below the second radial cell. Another less distinct spot is situated just beyond the second radial cell and another is located in about the middle portion of cell R_5. Also the basal portion of vein Cu is rather thickly covered with dark colored hairs. The costa ends just before the middle of the wing. The second radial cell is short, almost as wide as long. The section of vein R from r–m crossvein to the base of R_1 is about one-half longer than the second radial cell. The fork of cubitus is just beyond the apex of costa (fig. 52c). The alula is fringed with long hairs along its entire length; the squama has two long hairs on the middle margin. *Abdomen:* Entirely white to yellowish on the dorsum; each sternum marked with brown. Rather densely yellow haired, the hairs more dense and longer on the sides and on the posterior half of the abdomen. *Genitalia:* Largely brown, rather thickly covered with yellow to brownish yellow bristles. Diststyli yellow, slender and simple. Ninth tergum about as wide as long, broadest just beyond middle, attenuated apically. The membranous extension of the tergum not well developed, about two times wider than long. Apical lobes very lightly sclerotized, not darker than the membrane. The membranous portion bears a strong bristle on each side below apical lobes. Basistylar apodemes slender, rod-like, and joined in an anteriorly directed arch. Parameres well developed but fused together and pointed at the apex; appearing aedeagus-like. The aedeagus is broad, triangular in shape (fig. 52d).

Length: body, 1.6 mm.; wings, 1.4 mm.

FEMALE. Similar to the male except that the apical five antennal segments are cylindrical, three or four times longer than wide, and approximately equal in length. The scape of antenna is moderately developed and conspicuous, with

a row of strong setae around its margin. The third palpal segment is more swollen than in the male and has a large oblong sensory structure (fig. 52b). The costa extends to about middle of wing and the fork of Cu is approximately opposite end of the costa. The hairs along the costa are almost entirely dark colored and more dense than in the male. The abdomen is brown, tinged with yellow; the spermathecae are dark brown, moderately small, oval in shape with no attenuated portions, and the duct is apparently not sclerotized.

Holotype male and three paratype males: Honolulu, Oahu, December, 1951, at light (D. E. Hardy). Allotype female and one paratype female: Honolulu, January, 1953, at light (D. E. Hardy); one paratype male: Ewa, Oahu, light trap, June, 1955 (J. W. Beardsley).

Type and allotype in B. P. Bishop Museum. Paratypes deposited in the following collections: U.S. National Museum, Hawaiian Sugar Planters' Association, and the University of Hawaii.

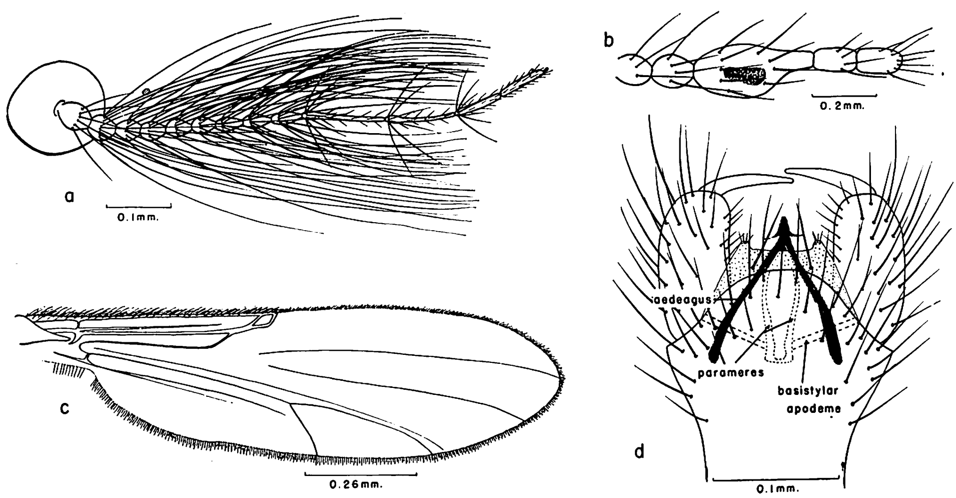

Figure 52—*Forcipomyia* (*Metaforcipomyia*) *fuscimaculata* n.sp.: **a,** antenna of male; **b,** palpus of female; **c,** wing; **d,** male genitalia, dorsal view.

Subgenus **PROFORCIPOMYIA** Saunders

Forcipomyia (*Proforcipomyia*) Saunders, 1956, Can. Jour. Zoo. 34:662.

Saunders characterizes the adults of this subgenus as having the "Basistylar apodemes in male genitalia joining in an arch, varying from broad and low to pointed; rudimentary parameres rarely present; aedeagus a simple triangular shield, often deeply excised in front." For a diagnosis of the larval and pupal characters refer to Saunders (1956).

Two Hawaiian species fit in this subgenus; one is apparently endemic, the other is an introduced species.

Type of subgenus: *Forcipomyia (Proforcipomyia) wirthi* Saunders.

Forcipomyia (Proforcipomyia) ingrami Carter (figs. 53a–e).

Ceratopogon sp. Grimshaw, 1901, Fauna Hawaiiensis 3:5.

Forcipomyia ingrami Carter, 1919, Ann. Trop. Med. and Parasit. 12:290.

Ceratopogon sp. Bridwell, 1920, Proc. Haw. Ent. Soc. 4:284.

Common on all of the Islands at most elevations.

Immigrant. Described from West Africa; it also occurs in Samoa, Indonesia, Malaya, British West Indies, Marquesas Islands, and probably is very widespread elsewhere.

Cotype series in the British Museum (Natural History).

This is the most abundant midge and is one of the commonest of flies throughout the Hawaiian Islands. The species is very common in the mountains and is often found in habitats where normally just the endemics occur. During the wet months it becomes very abundant throughout the lowlands.

First recorded from Hawaii by Macfie (1934a:134) and by Williams (1936a: 111). Macfie studied a good series and said the specimens from Hawaii "are exceptionally dark in colour, but do not seem to differ from typical examples of *F. ingrami* in any material respect, except in having the first tarsal segment in the males unusually long, slightly longer than the second segment instead of rather shorter. The tarsal ratio being about 1.1 instead of about 0.8. The genitalia of the males appear to be indistinguishable from those of *F. ingrami*. For this reason, and because *F. ingrami* is known to be somewhat variable, there does not seem to be any sufficient reason for considering these specimens as distinct from that species." Macfie's study was based upon 20 specimens taken from a wide variety of localities on Oahu and Hawaii.

F. ingrami is related to *F. palikuensis* n. sp.; but the genitalia are very different (figs. 53b and 54b), the legs are usually pale, and the females are usually golden haired.

MALE. Moderate sized, black-bodied, very densely pilose flies. Vestiture of body black, that of legs mostly yellow. Mesonotum gray pollinose. Antennae very densely plumose. In the Hawaiian species the two apical segments (14 and 15) are approximately equal in length. Segment 13 is almost equal to segments 14 plus 15, and 12 is about equal to 13 plus 14 (one-half longer than 13) (fig. 53a). Ingram and Macfie (1924:584–587), in their redescription of *ingrami*, state that segment 12 is nearly three times longer than 11 and two times longer than the 14th. In the Hawaiian specimens, 12 is about three and one-half times longer than 11, and 11 is about three times longer than the 14th. The palpi are distinctly five-segmented; the third segment is slightly longer than 4 plus 5, is swollen just below the middle, and has a moderately large sensory structure. The apical segment of the palp is small, about half as long as segment 4 (fig. 53d). Legs yellow, front basitarsus about one-half longer than second segment; middle and

hind basitarsus slightly longer than second tarsal segment. Ingram and Macfie (1924) state that in *ingrami* (from Africa) the first tarsal segment in the male is slightly longer than the second on the front legs and slightly shorter than the second on the middle and hind legs. The wings are densely covered with dark-colored macrotrichia. The alula is fringed for about two-thirds to three-fourths its length. The subcostal vein enters the costa just slightly before the base of R_1. The first radial cell is obliterated; the second is short. Vein R_{4+5}, from the base of R_1 to the wing margin, is less than half the length of the radial vein from R_1 to the r–m crossvein. Fork of cubitus is well beyond the apex of the costa (fig. 53e). The dististyli of the male genitalia are simple, rather slender, and with no ventral lobes. The membranous extension of the ninth tergum is about one-third wider than long. The apical lobes are moderately developed (fig. 53b). The aedeagus is triangular in shape, pointed at apex. Parameres are absent. The basistylar apodemes are joined in a broad arch in the middle.

Length: body, 1.6–2.4 mm.; wings, 1.5–1.8 mm.

FEMALE. Head and body predominantly golden yellow pilose. The pile of the mesonotum is often yellow to black intermixed, and some specimens may have entirely dark-colored hairs. The scutellum is yellow, lightly tinged with brownish; the anterior corners of mesonotum are rufous, tinged with brown. The pleura are tinged with rufous, the abdomen is often brown. The last five antennal segments are cylindrical, approximately equal in length, and about three to four times longer than wide (fig. 53c). The palpi are as in the male but the third segment is more swollen in the middle and with a larger sensory structure. The fork of cubitus is situated slightly before the apex of costa and the second radial cell is elongate. Two medium-sized spermathecae are present; they have very short, straight necks.

Length: body, 1.5–1.7 mm.; wings, 1.4–1.6 mm.

Note: Specimens vary considerably in size and coloration. Some of the females have the scutellum entirely dark brown to black with just a faint tinge of yellow in the ground color. Although the legs are predominantly yellow, some specimens from the mountains have dark-colored legs.

Johannsen (1952:149) indicated that *Forcipomyia* are terrestrial, developing "in manure, under the decaying bark of trees, and similar situations" (see Long, 1902; Saunders, 1956). *Forcipomyia ingrami* (in Hawaii) breeds in a wide variety of aquatic and semi-aquatic situations—in bogs, shallow water ponds and streams choked with vegetation, at the bases of leaves of plants where water collects, among wet leaves and trash in the forest, "as well as in the dense cover of the uluhe fern" (from Williams, 1944:176). In West Africa Ingram found the larvae to be semi-aquatic and to prey upon mosquito larvae. The adult females of some species of this genus are known to feed upon the blood of other insects (Wirth, 1956b). The feeding habits of the adults have not been observed in Hawaii. For an account of the breeding habits and characteristics of the immature stages, see Williams (1944:173–176). He says the larvae breed in very thin sheets of slow or stationary water or in and about water held by plants, etc. The larvae have the body segments thickly covered with strong bristles and spines, and both posterior

and anterior prolegs are present. The pupae have one or more pairs of spinose processes on the thorax, in addition to the respiratory organs, and spines are also present on the anterior abdominal segments.

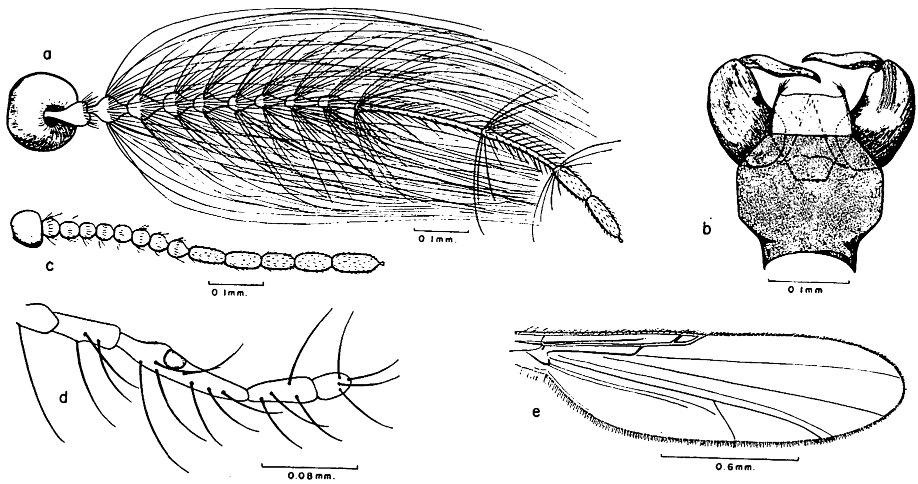

Figure 53—*Forcipomyia (Proforcipomyia) ingrami* Carter: **a,** male antenna; **b,** male genitalia, dorsal view; **c,** female antenna; **d,** palpus of male; **e,** wing.

Forcipomyia (Proforcipomyia) palikuensis, new species (figs. 54a–d).

Much like *Forcipomyia ingrami* Carter but distinguished by the details of the male genitalia. Ordinarily the species can be recognized by the dark-colored brown to black legs of both sexes and by the all black vestiture of the female. These latter characters, however, cannot be wholly relied upon since *F. ingrami* is rather variable in coloration and specimens have been seen from the mountains which have dark-colored legs and dark hairs on the body of the female. The genitalia of *palikuensis* are distinctive because of the presence of a submedian lobe on the venter of each diststylus, the indistinctly trilobed aedeagus, and the nearly parallel-sided arms of the basistylar apodemes (fig. 54c); compare with figures 53b and 54b. Also, the membranous extension of the ninth tergum is two times wider than long and the sclerotized portion of the ninth tergum is concave apically (fig. 54b).

MALE. Predominantly black species; pile of thorax all black, that of head and appendages brown to black, and of legs brown to brownish yellow. *Head:* Eyes bare, narrowly separated in middle of front by width of nearly two facets. Antennae very densely plumose, 15-segmented counting ring-like scape; pedicel very large, nearly filling the space between eyes and hiding the poorly developed scape. The

first seven flagellar segments are nearly circular, as wide as long. Flagellar segments 8 and 9 swollen at bases with short attenuated necks and apices. The tenth flagellar segment swollen at base and long and slender, slightly longer than segments 11 and 12 combined; 11 is slightly swollen at base and is almost equal to the two apical segments minus the nipple-like tip. The last two segments are approximately equal in length; the last has no whorl of long hairs but is rather thickly covered with short hairs, the projected tip portion is slightly expanded apically (fig. 54a). The palpi are five-segmented, brown, lightly tinged with yellow. The third segment is slightly swollen on the basal third and about one-fourth longer than the two apical segments combined. There is no visible sensory structure on the third segment. The apical segment is about two-thirds as long as the penultimate. *Thorax:* Shining black in ground color, lightly gray pollinose. The halteres are dusky brown; the extreme apices of the knobs are white. Scutellum with about eight long hairs on the margin, the longest of these about one-half longer than the scutellum. *Legs:* Predominantly dark colored, the middle and hind legs are entirely dusky brown to black, very faintly tinged with yellow in the ground color; the front legs are more distinctly tinged with yellow, discolored with brown. The segments are covered with numerous long bristles, as is typical of members of this genus. The basitarsus of the front leg is one-third longer than the second tarsal segment. That of the middle leg is slightly shorter than the second segment; that of the hind leg, just slightly longer than the second segment. The empodium is well developed on all tarsi. *Wings:* Moderately covered with macrotrichia, but not as densely so as is typical for *F. ingrami*. The alula is fringed along its entire length and each squama has several long hairs. The costa ends near the middle of the wing. The first radial cell is obliterated; the second is about two times longer than wide and is about one-third as long as that section of radial vein from r–m crossvein to base of R_1 (fig. 54d). The fork of cubitus is well beyond the apex of the costa. Wings rather long and narrow; three and one-half times longer than wide. *Abdomen:* Subshining black in ground color covered with grayish pollen. Pile rather dense and brown to black. Abdomen slender and elongate; over two times longer than the head and thorax combined. *Genitalia:* Thickly covered with long, dark-colored hair; the longest hairs on the tergum are equal in length to the sclerite. The long hairs on the basistyli are approximately two times longer than that sclerite. Each dististylus with a rounded lobe on venter just below middle. Aedeagus roughly triangular with the apical portion narrowed into a median lobe and with a small subapical lobe developed on each side. The basal portion of the aedeagus is concave (fig. 54c). Parameres are absent. The basistylar apodemes are slender, rod-like, and are joined in the middle in a flat-topped arch. Each of these apodemes possesses a small lobe on outer edge near basal two-thirds (fig. 54c). The ninth tergum is about as wide as long and is broadest at the median portion, slightly attenuated apically. The extended membranous portion is two times wider than long; the apical lobes are rather short (fig. 54b).

Length: body and wings, 1.8 mm.

FEMALE. Very similar to *F. ingrami* but lacking the golden yellow pile on the

mesonotum which is typical of that species. Also the legs are discolored with brown. The last five antennal segments are cylindrical, three to four times longer than wide, and all approximately the same length. The third palpal segment is slightly more swollen than in the male and has an oblong sensory structure just below the middle. The second radial cell is elongate, about equal in length to that section of radial vein from r–m crossvein to the base of R_1. The ring-like scape of the antenna is distinctly developed and has a row of moderately strong bristles around its margin. The basitarsi of the front and hind legs are about one-half longer than the second tarsal segment and those of the middle legs are about one-third longer than the second segment. The legs are yellow, discolored with brown. The spermathecae are dark brown to black, oval in shape and with short, straight necks. Abdomen shorter, broader, dark brown in color. Otherwise as in the male except for slightly smaller size.

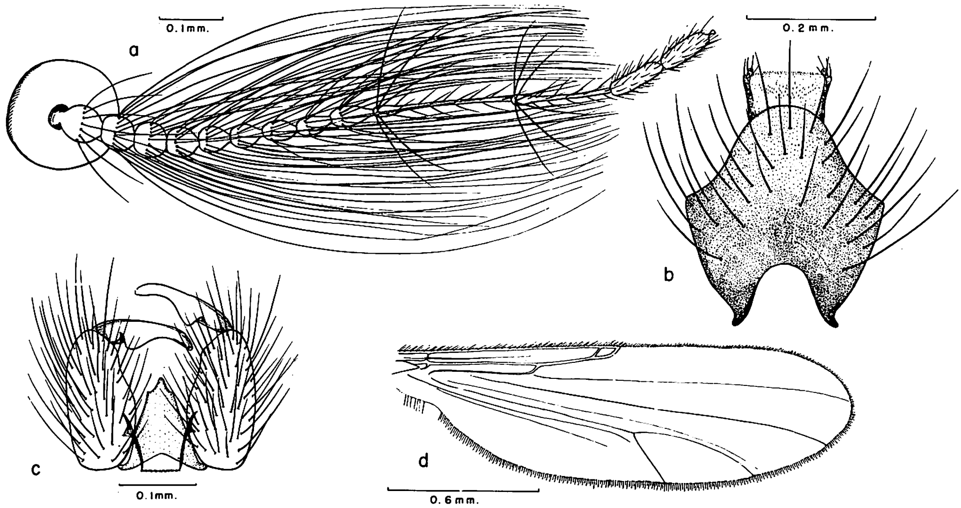

Figure 54—*Forcipomyia* (*Proforcipomyia*) *palikuensis* n.sp.: **a,** male antenna; **b,** ninth tergum of male genitalia; **c,** male genitalia with tergum removed; **d,** wing.

Length: body and wings, 1.6 mm.

Holotype male, allotype female, and 29 paratypes (17 males and 12 females): all from Paliku, Haleakala Crater, Maui, 6,500 ft. elevation, June, 1952, and June, 1953 (D. E. Hardy, M. Tamashiro, and C. R. Joyce).

The type, allotype, and a series of paratypes are being deposited in the B. P. Bishop Museum. The remainder of the paratypes are being deposited in the following collections: U.S. National Museum, British Museum (Natural History). Hawaiian Sugar Planters' Association, and the University of Hawaii.

This species has been taken only in the extreme eastern portion of Haleakala Crater. This is a wet region receiving approximately 150 inches of rain per year and is the only portion of the crater which would be at all suitable for semi-aquatic insects.

Subgenus **TRICHOHELEA** Goetghebuer

Apelma Kieffer, 1919, Ann. Mus. Nat. Hung. 17:64.
Trichohelea Goetghebuer, 1920, Mem. Mus. Roy. Hist. Nat. Belg. 8:18.

Preoccupied by *Apelma* Billberg, 1820, Enum. Ins. in Mus. Billberg, 53 (Coleoptera).

As pointed out by Wirth (1956:358), *Apelma* Kieffer is preoccupied and must be replaced by *Trichohelea* Goetghebuer.

Most authors have treated *Trichohelea* (as *Apelma* Kieffer) as a subgenus of *Forcipomyia* distinguished by having the empodium well developed in the female and lacking or vestigial in the male and by having the hind basitarsi more elongate. As defined by Saunders (1925 and 1956) this group has the internal structures of the male genitalia very differently developed than in other *Forcipomyia;* the characteristic feature is the short, rather H-shaped internal sclerotization (parameres plus basistylar apodemes, joined by a crossbar) (fig. 55e). "Parameres spoon-shaped, joined by crossbar, extending back from forward-projecting basistylar apodemes, the whole making an internal chitinization roughly H-shaped."

Johannsen (1952:151) also uses these characters for separating *Apelma* Kieffer from *Forcipomyia*. Goetghebuer (1933:6) treats *Apelma* as a synonym of *Forcipomyia*. Lenz (1934:99), in dealing with the immature stages, in the same work as the preceding author, treats *Apelma* as a distinct genus. According to Lenz the larvae differ from other Ceratopogonidae by having rudimentary antennae and the head flattened dorsoventrally and in the same longitudinal axis as the body.

Malloch (1915:312) proposed the genus *Euforcipomyia* for those species of *Forcipomyia* which have a distinct empodium in both sexes and the hind basitarsi one and one-half to two times longer than the second segment. This would fit the present concept of *Trichohelea* except for the lack of an empodium in the males of the latter group. Also the male genitalia apparently differ in important details as pointed out by Wirth (1952:143).

I have seen only *Trichohelea brevis* (Johannsen). This species shows rather remarkable sexual dimorphism, which has apparently not been reported for any other species of *Forcipomyia*. It also exhibits a number of important characters which have apparently not been pointed out in the literature. In this species the alula is bare (it is supposed to be fringed in other *Forcipomyia*). The female antennae are reduced to 11 segments in the one Hawaiian species with only 3 short compressed segments beyond the first flagellar (slightly wider than long) (fig. 55b). In other Hawaiian *Forcipomyia* the female antennae are 15-segmented with 8 shortened (longer than wide) segments beyond the first flagellar (fig. 53c). Saunders (1925) says the females of *Trichohelea* (as *Apelma* Kieffer) may be distinguished from *Forcipomyia* by the strongly compressed flagellar segments of antennae. He did not say how many segments were involved and it is not clear with what species he was dealing. The females of the genotype have apparently not been studied, but, if it should prove to have reduced antennae plus the lack of a fringe on the alula (or if other species related to *brevis* should be found),

these characters combined with the elongated basitarsi and lack of empodium in the male should give ample ground for considering this as a distinct genus, although Saunders (1956) reports that some species do have 15-segmented antennae.

According to Saunders (1925; 1956) the immature stages are aquatic, living in the water caught in the leaf axils of various water-holding plants. Saunders said the dorsoventrally flattened shape of the larvae enables them to exist in the capillary water between the closely appressed leaves of the plants. When the water is dumped out of the plant, the larvae remain appressed to the leaves. Illingworth (1929b:206) found the larvae of *F. brevis* breeding in abundance in the axils of pineapple leaves. He gave a brief account of the life cycle (1934b) and noted that the larvae apparently feed upon wind-borne decomposing organic matter that washes down between the leaves. He could find no visible abrasion of the epidermis of the plant, and said there was no conclusive evidence that this species causes any damage to the plant. He found that the entire life cycle requires 36 to 53 days and that the immature stages develop continuously throughout the year. Williams (1944:172) also made some notes on the life history and habits of this species. An excellent account of the morphology of the larvae and pupae of *Trichohelea* (as *Apelma* Kieffer) is given by Saunders (1925).

Type of subgenus: *Apelma auronitens* Kieffer.

Forcipomyia (Trichohelea) brevis (Johannsen), **new combination** (figs. 55a–f).

Apelma brevis Johannsen, 1927, Proc. Ent. Soc. Wash. 29:205.

Endemic. Oahu (no type locality given in original description; "The specimens upon which the descriptions are based were collected in Hawaii by Dr. J. F. Illingworth . . .") and Lanai. Probably occurs generally in pineapple fields throughout the Islands.

Type in the U.S. National Museum.

Forcipomyia (Trichohelea) brevis apparently differs from other species which have been treated under the name "*Apelma* Kieffer" by the shortened 12th antennal segment of the male (the 12th is about equal to the 13th rather than being one-half to two times longer), by its smaller size, and also probably by the reduced segmentation of the female antennae (fig. 55b). It is distinguished from all other ceratopogonids in Hawaii by the subgeneric characters discussed above and pointed out in the key to subgenera.

MALE. Tiny, predominantly brown to brownish yellow species. Head yellow-brown with dark hairs, eyes bare. Palpi yellowish, tinged with brown; the first segment fused with the second, not clearly defined, and appearing as a swelling at the base of the second segment; the third segment is almost as long as 4 and 5 combined and has a tiny circular sensory structure near the middle (fig. 55c). The last four antennal segments elongated; apical segment one-half longer than penultimate. Segments 12, 13, and 14 about equal in length, approximately three times longer than wide. Segments 12 and 13 swollen at bases. The nipple-like

projection at apex of segment 15 is about one-seventh as long as the remainder of the segment (fig. 55a). Eyes narrowly separated on the front. Thorax typically subshining brown to black with gray pollen on the mesonotum and with humeri, upper portions of pleura, extreme posterior angles of mesonotum, and scutellum yellow. Specimens are at hand which have the thorax almost yellow, just slightly tinged with brown; these may be teneral. Mesonotum sparsely covered with short, pale hairs and longer, brown setae. Margin of scutellum with eight long setae, the longest of these nearly two times longer than the scutellum. Halteres entirely yellow. Legs yellow, tinged with brown. The hind basitarsi are approximately equal in length to the next three tarsal segments. On the front and middle tarsi the basitarsus is just slightly longer than the next two segments. The empodium is completely lacking. Wings rather densely covered with macrotrichia; the costa ends near the middle of the wing. The second radial cell is elongate, about four times longer than wide and approximately equal to that section of radius from the r–m crossvein to the base of R_1. The apical portion of second radial cell acutely pointed. The cubitus forks about opposite the tip of the costa (fig. 55d). The alulae are entirely bare; the squamae each have two or three

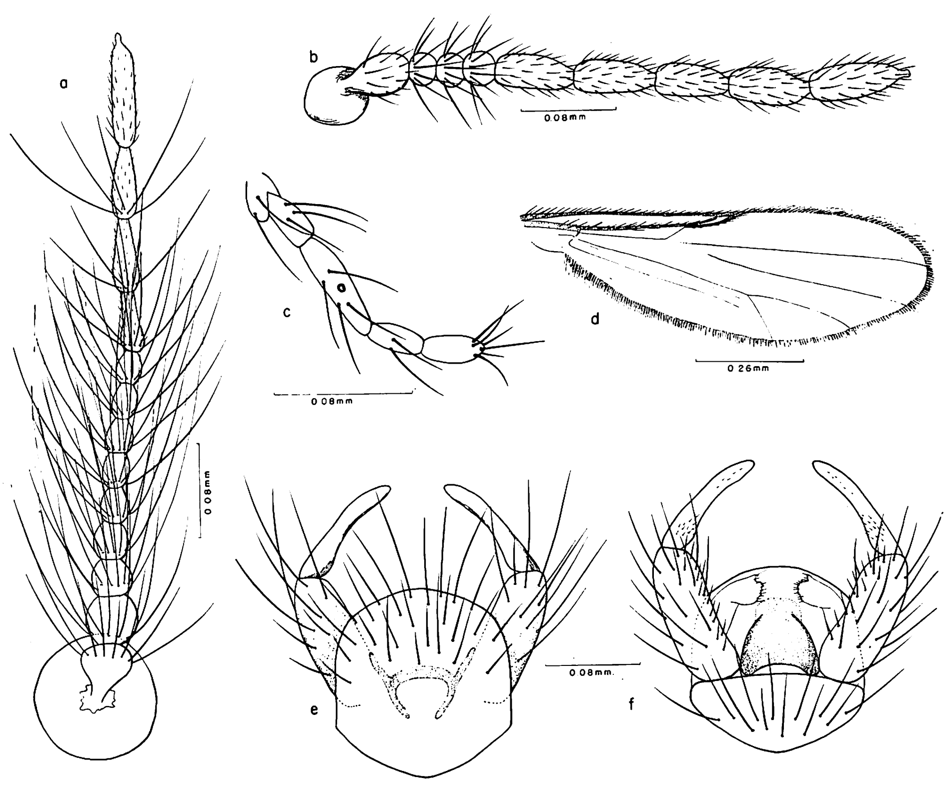

Figure 55—*Forcipomyia* (*Trichohelea*) *brevis* (Johannsen): **a,** male antenna; **b,** female antenna; **c,** palpus of male; **d,** wing; **e,** male genitalia, dorsal view; **f,** male genitalia, ventral view.

hairs on the middle margin. Abdomen typically brown to black, yellow-brown in some specimens. The conjunctiva at side of each segment with a small patch of dark-colored setae. Ninth tergum broadly convex on hind margin, approximately as wide as long and with no membranous extension of the posterior margin or with the apical lobes (cerci) as in other *Forcipomyia* (fig. 55e). The diststyli are simple and the basistyli are comparatively narrow (fig. 55f). The aedeagus is short and broad and the parameres and adjoining processes are characteristic in shape; they are roughly H-shaped (fig. 55e). These inner processes have been figured by Johannsen (1943, fig. 68; 1952, fig. 68).

Length: body, 1.0–1.3 mm.; wings, 0.8–1.0 mm.

FEMALE. Paler colored than male, largely yellow-brown. Antennae with just 11 segments; the first flagellar segment is oval, about one-half longer than wide, and the next three segments are round, as wide as long. The apical five segments are cylindrical, approximately equal in shape, and with the last segment slightly longer than the others. Segments 7 to 9 are about four times longer than wide. Segment 10 is about two times longer than wide, and the apical segment about three times longer than wide (fig. 55b). Two oval spermathecae are present; there is no evidence of a sclerotized duct.

Length: body and wings, 0.85–1.0 mm.

See Johannsen (1927:207–208) for discussion of the immature stages.

The larvae are distinguished by the simple (not finned) lateral setae; the white head which is two-thirds longer than wide, and by the four simple blood gills. The species was described as "A new midge injurious to pineapple plants." Illingworth, in correspondence with Johannsen, wrote, "This fly is a troublesome pest of pineapple plants. It breeds in the water-pockets in the axils of the leaves. The maggots make slight scars on the very tender, white tissue of the leaf, and bacteria entering the scars cause a rot of the whole plant." Illingworth later (1934b:542) changed his mind and said "we have no conclusive evidence that they cause infections." At the present time there is no apparent evidence that these flies are causing any damage whatsoever to pineapple plants.

Subfamily Dasyheleinae Lenz

Dasyheleinae Lenz, 1934, in Lindner's, Die Fliegen der Palaear. Reg. 13a:112.

Differentiated from Forcipomyiinae by having the empodium vestigial in both sexes, the eyes pubescent, and the second radial cell squared at apex.

According to Thompsen (1937:60) the larvae of Dasyheleinae differ from those of Forcipomyiinae by lacking prolegs on the prothorax and from the Ceratopogoninae (Heleinae) by having terminal hooks on the last body segment and ventrally directed mouthparts.

Only the genus *Dasyhelea* Kieffer occurs in Hawaii.

Key to Species of Dasyhelea Kieffer

1. Mesonotum dark brown to black in both sexes. Cell R_2

distinct. Male with lateral appendages arising at apex of 9th tergum (fig. 56a) 2

Mesonotum bright yellow with three brown vittae. Second radial cell nearly obliterated and no appendages present on 9th tergum .... **platychaeta n. sp.**

2. The costa ends just beyond middle of wing. Fork of Cu nearly opposite the apex of costa in both sexes (slightly in the male) (fig. 56d). One spermatheca present in female. Wings of both sexes covered with macrotrichia......... .... **hawaiiensis** Macfie.

The costa extends about two-thirds the wing length in the female. In the female the fork of cubitus is well beyond apex of costa, about opposite the apex of r–m crossvein. In the male it is distinctly before end of costa. Two spermathecae present. Wings nearly devoid of macrotrichia .... **calvescens** Macfie.

Genus **DASYHELEA** Kieffer

Dasyhelea Kieffer, 1911, Bul. Soc. Hist. Nat. Metz. 27:5.
Prokempia Kieffer, 1913, Rec. Ind. Mus. 9:163.
Pseudoculicoides Malloch, 1915, Bull. Ill. State Lab. Nat. Hist. 10:309.
Tetrahelea Kieffer, 1925, Arch. Inst. Pasteur d'Algerie 3:422.
Cryptoscena Enderlein, 1936, Tierwelt Mitteleur. 6:51.
Dicryptoscena Enderlein, 1936, Tierwelt. Mitteleur. 6:51.
Tetraphora of authors (not Philippi 1865).

Distinguished from other ceratopogonids by the vestigial empodium; the pubescent eyes; the rather long, slender, hind basitarsi; the squared apex of cell R_2; and by the absence, in Hawaiian species, of a nipple-like projection at the tip of the terminal antennal segment. Also, the other segments of the antennae are differently developed than in other genera present in Hawaii. Refer to figures 55b and 57a. The palpi have only four clearly defined segments; the basal segment is fused or rudimentary.

Type of genus: *Dasyhelea halophila* Kieffer.

Dasyhelea calvescens Macfie (figs. 56a–b).
Dasyhelea calvescens Macfie, 1938, Proc. Roy. Ent. Soc. Lond., ser. B. Tax. 7:157.
Ceratopogon sp. Bridwell, 1920, Proc. Haw. Ent. Soc. 4:284.

Endemic. Oahu (Type locality: Hanauma Bay) and Kauai. Probably on all the main islands. These are marine insects breeding along the seacoast and in salt marshes near the coast.

Type in British Museum (Natural History).

Macfie, in the original description, said this species differs from all other *Dasyhelea* known to him in having the wings practically devoid of macrotrichia. The species superficially resembles *D. hawaiiensis* Macfie, but differs strikingly in habits and details of structure. The coloration of both species seems quite variable and cannot be relied upon. The details of the wing venation, and structure of the antennae, palpi, and genitalia present the best characters for differentiating this species. (See characters in above key and in the description and figures below.)

MALE. Small, predominantly dark brown to black species. Eyes densely pubescent, separated on the front by a width of two to three facets. Antennae 15-segmented, the narrow ring of the scape visible below base of pedicel. First flagellar segment with an attenuated basal portion about equal to remainder of segment. None of antennal segments noticeably elongated. The apical one is the longest, is a little less than three times longer than wide, and about one-third longer than penultimate segment (14); the tip is not projected. Segment 14 is two times longer than wide and equal in length to 13. Segment 13 is somewhat attenuated on apical half, two and one-half times longer than wide, and about one-third longer than number 12. Segment 12 is two times longer than wide and approximately the same length as the preceding segments. The two apical segments of palpi just slightly shorter than two preceding segments. The third segment (second visible) is but little longer than apical segment. Thorax opaque brown to black in ground color and covered with gray pollen; scutellum, sides, and anterior corners often dull yellow to rufous; this coloration is variable, and these areas may be entirely dark colored in some specimens. Halteres white. Legs yellow, tinged with brown; basitarsi of all legs about equal to the next three tarsal segments. Macrotrichia almost entirely lacking on wings; costa extending about two-thirds wing length, proportions of costa to wing length are about 75 to 125. Fork of cubitus situated before end of costa about opposite end of vein R_1. Abdomen brown to black with a small patch of dark setae in membrane on sides of each segment. Ninth tergum approximately as wide as long, the lobes extending beyond the hind margin submedian in position, situated rather close together (fig. 56a). The ninth sternum is produced into three processes on hind margin. The dististyli are simple. The aedeagus is narrow, rather slender, with a large flat extension to each side from the base. The parameres consist of a moderately broad basal bar and two rather slender arms extending posteriorly (fig. 56b).

Length: body and wings, 0.8–1.0 mm.

FEMALE. Usually paler colored on the mesonotum and scutellum than in the male, pleura often tinged with yellow. The last segment of the antenna is nearly two times longer than penultimate segment. The segments preceding the last are approximately equal in length. The proportion of the costa to the wing length is 80:127. The fork of cubitus is situated about opposite the end of the subcostal vein just slightly beyond the apex of r–m crossvein. Two spermathecae are present; these are dark brown in color, oval in shape, and have very short, straight necks.

Williams (1944:180) has studied the biology of this species. Wirth (1946:592) found the larvae breeding at Hanauma Bay, Oahu, in the "felt-like growth of

algae and diatomes in the shallow pools in the rocks receiving the splash from the sea at high tide."

Dasyhelea hawaiiensis Macfie (figs. 56c–f).
Dasyhelea hawaiiensis Macfie, 1934, Stylops 3(6):133.

Endemic. Oahu (Type locality: HeringValley, Tantalus) and Hawaii. Commonly collected at lights and by sweeping vegetation near water throughout Oahu from sea level to mountain tops. It breeds in fresh water. It probably is found on most of the main islands.

Type in British Museum (Natural History).

Similar to *calvescens* but differing strikingly in habits and in structural details. The specimens are predominantly more shining black, the wings are densely covered with macrotrichia, the females have but a single spermatheca, the costa ends near the middle of the wing, the fork of cubitus lies approximately opposite the end of costa, and the male genital structures are very different as described and figured below. *D. hawaiiensis* is most readily differentiated from all other known *Dasyhelea* in Hawaii by the development of the lobes at the apices of the ninth tergum. A pair is developed on each side; the outer lobe is comparatively long and slender (fig. 56e).

MALE. *Head:* Eyes densely pubescent, separated on the front by a width of two to three facets. Last four antennal segments cylindrical. Segments 12 and 13 are approximately equal in length, about four times longer than wide, and slightly longer than segments 14 and 15. The last two segments are equal in length. Third (second visible) palpal segment slender, equal to the last two segments (fig. 56c). Thorax shining brown to black. Scutellum varying from brown to bright yellow in color. Legs yellow-brown to yellow. Basitarsi approximately equal to next three tarsal segments on all legs. Wings rather thickly covered with macrotrichia. The costa ends just beyond middle of wing in both sexes, and the fork of cubitus is just slightly beyond the apex of the costa (fig. 56d). Ninth tergum slightly longer than wide, bearing a pair of lobes on each posterior lateral margin. The inner pair are short and covered with numerous hairs. The outer pair are comparatively elongate, finger-like, with a single bristle at apex. Dististyli slender, overlapping at apices. Aedeagus short and broad with two processes from the apex; parameres as in figure 56f.

Length: body and wings, 0.9–1.3 mm.

FEMALE. Similar to male but usually paler in color. The apical antennal segment is about one-half longer than the penultimate; segments 11 to 14 are approximately equal in length and just slightly longer than the preceding segments. The fork of Cu is opposite the apex of costa. Just a single, rather small, spermatheca is present; it has a very short straight neck.

Williams (1944:176–178) gives an excellent account of the biology of this species. He found it breeding commonly on wet banks in the mountains and in mountain streams among algae thinly covered by flowing water. In addition, he found it breeding in leaf axils of *Dubautia* on Mt. Olympus, Oahu.

Wirth (1946:492) pointed out the variability of the color in this species. He found specimens from the mountains ranging from entirely black to those marked with bright yellow. The specimens which he reported taken in light trap on Judd Street, Honolulu, and which were a brilliant yellowish green with small brown thoracic markings, were evidently *D. platychaeta* n. sp.

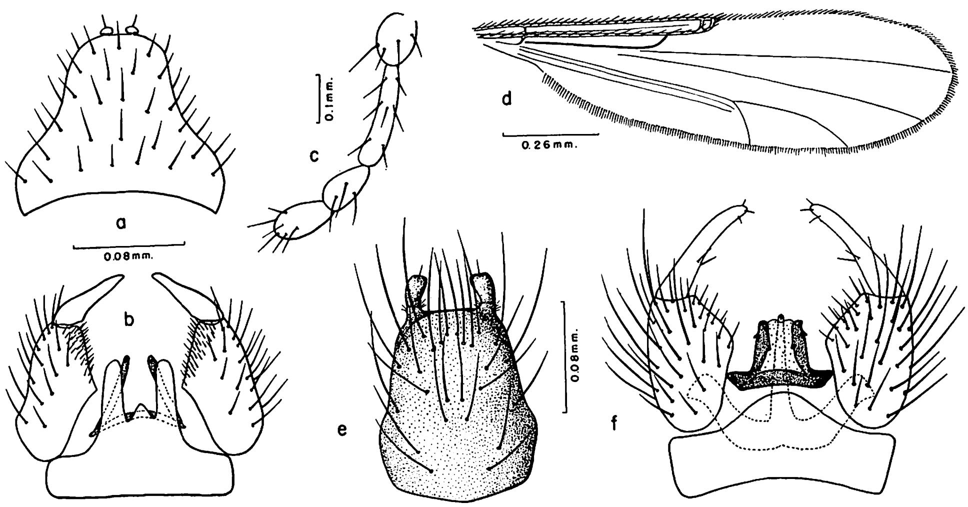

Figure 56—*Dasyhelea calvescens* Macfie: **a,** ninth tergum of male genitalia; **b,** male genitalia, ventral view. *D. hawaiiensis* Macfie: **c,** palpus of male; **d,** wing; **e,** ninth tergum of male genitalia; **f,** male genitalia, ventral view.

Dasyhelea platychaeta, new species (figs. 57a–e).

A small species readily differentiated from other Hawaiian *Dasyhelea* by the predominantly canary yellow color and three brown vittae on the mesonotum of the female, by the flat scale-like setae on the antennae, and by the male genitalia. It resembles *D. esakii* Tokunaga (1940a:212) from the Caroline Islands but has no dark ring at middle of each femur, the wings have no black markings, the second radial cell is nearly obliterated, and the area formed by veins R_1 and R_{4+5} is rectangular, not square. The fork of cubitus is approximately opposite the apex of costa, not "under base of second radial cell." The last antennal segment is one-half longer than the penultimate segment. (Tokunaga's figure shows the last segment nearly two times longer although in his discussion he says the proportions are 15:21.5.) The thorax is predominantly yellow, not yellow-white. The yellow vittae of mesonotum are not separated by two black lines. The median vitta extends only to the front of the depressed area and does not consist of "a dark median line on anterior part, a large dark cloud on middle part, and two small black spots on posterior margin just before scutellum." It also apparently resembles *D. raripilosa* Tokunaga (1940b:172); but the posterior median portion of mesonotum is entirely yellow, the second radial cell is reduced

to a barely perceptible spot, the fork of Cu is nearer the apex of costa, and the antennal segments are differently developed (most flagellar segments are about two times longer than wide, not subspherical, have no evidence of basal striations on segments, and apical portions of segments 7 to 14 are attenuated). The flat scale-like setae on the apical antennal segments and the large circular single spermatheca are probably characteristic. (Tokunaga did not mention these characters.) This may possibly be the *Dasyhelea* sp. mentioned by Bohart and Gressitt (1951:64) from Guam, a "minute yellow gnat with three longitudinal dark stripes on the mesonotum; length 0.8 mm." This was the abundant fly on the garbage dump at Pago.

FEMALE. *Head:* Yellow, brownish on the vertex, occiput, and clypeus. Eyes separated on the front by the width of about two facets. Apical antennal segments not constricted at tip, two and one-half times longer than wide and one-half longer than penultimate segment. Preceding five antennal segments (10 to 14) approximately equal in length, 10 just slightly longer than the others; apices of segments gradually narrowed. The last five segments bear flat scale-like setae, these more numerous on apical segments (fig. 57a). Palpi with four distinct segments, number 1 fused with the head or with the base of the second. The second visible segment is three times longer than wide and nearly equal to the last two; it has no visible sensory structures but has numerous capitate setae on inner surface on basal half (fig. 57b). *Thorax:* Canary yellow with three brown vittae on mesonotum (fig. 57c). The lateral vittae extend from just in front of anterior

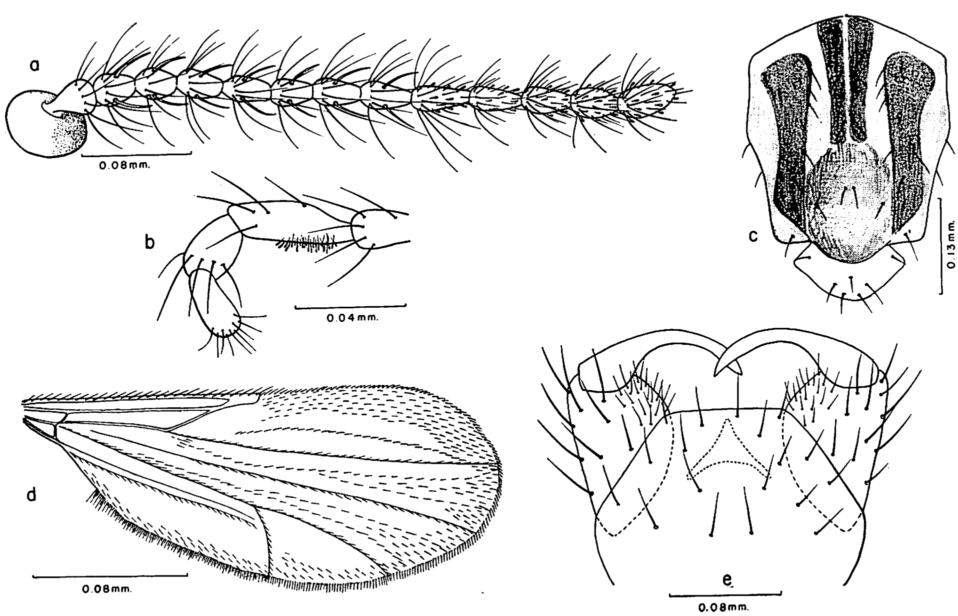

Figure 57—*Dasyhelea platychaeta* n.sp.: **a,** female antenna; **b,** palpus of female; **c,** mesonotum, dorsal view; **d,** wing; **e,** male genitalia, dorsal view.

corners of scutellum to a level opposite hind portion of humerus. The median vitta extends from the front margin to the anterior edge of the depressed area. Vestiture brown. Scutellum, halteres, all of pleura, and venter bright yellow. *Legs* yellow, knees brown; basitarsi of all legs about equal in length to next three tarsal segments. *Wings:* Rather thickly covered with macrotrichia. Costa ending slightly before middle of wing. Second radial cell obliterated or nearly so, the area formed by R_1 and R_{4+5} rectangular and equal to radial vein from r–m crossvein to vein R_1. Fork of cubitus slightly before a point opposite apex of costa (fig. 57d). *Abdomen:* Terga 1 to 5 all brown; the sixth is discolored with brown in the middle and the apex, sides, and venter are bright yellow. Just a single large, brown spermatheca is present; this is equal in width to the genital segment of the abdomen.

Length: body, 7.5 mm; wings, 7.0 mm.

MALE. One male on hand was taken in the same sample as some of the females in the type series and appears to belong here although it is predominantly dark colored and the mesonotum is indistinctly vittate. The flat scale-like setae are numerous on antennal segments 12–15. Segments 14 and 15 are about equal in length. Segment 12 is slightly longer than 15 and about equal in length to 13. The thorax is brown with a yellowish vitta down each dorsocentral line. Abdomen all brown. The genitalia differ from all other Hawaiian species by lacking the lobes beyond the posterior margins of the ninth tergum (fig. 57e). Ninth tergum is broader than long. Dististyli slender, rather elongate, equal in length to basistyli and overlapping at apices.

Length: body, 8.5 mm.; wings, 8.0 mm.

Allotype female (plus the above male specimen): from Ewa, Oahu, light trap, May–June, 1955 (J. W. Beardsley). Paratypes (7 females): 4, same data as type; 2, Honolulu, at light, Nov., 1945; and Jan., 1951 (W. W. Wirth and D. E. Hardy); and 1, Waipio, Oahu, light trap, Oct., 1955 (J. W. Beardsley).

Type and two paratypes in the B. P. Bishop Museum. Paratypes deposited in the following collections: U. S. National Museum, Hawaiian Sugar Planters' Association, and the University of Hawaii (also the male in the latter collection).

Family SCATOPSIDAE Newman
The Minute Black Scavengers or Dung Midges

Scatopsites Newman, 1834, Ent. Mag. 2:387.
Scatopsides Zetterstedt, 1840, Insecta Lapponica:800.
Scatopsina Rondani, 1856, Dipt. Ital. 1:36.
Scatopsidae Enderlein, 1911, Arch. Naturgesch 77, Suppl. 3:122.

The family name is derived from the Greek skatos, dung.

Small to minute, predominantly black flies recognized by their characteristic wing venation, lack of tibial spurs, one-segmented palpi, and short compact antennae. The anterior veins, made up of the subcosta, R_1, and R_{4+5}, are thickened

and dark colored with R_{4+5} ending in the costa near the middle or well before apex of the front margin of the wing. Vein M_{1+2} is joined with the radial vein at its base and is forked in the outer portion of the wing; crossvein r–m sometimes present as an appendage on the upper side of M_1 near base (fig. 58a) or M_1 may evanesce at its base. Vein Cu_2 turns down sharply toward the hind margin of the wing in some of our species. The m and m–cu crossveins are lacking (fig. 60a). The antennae are composed of 9 to 10 well differentiated, closely joined segments. The terminal segment is three times longer than the penultimate and it appears to be made up of three fused segments; three rows of verticilli are present on most of our species but are not clearly differentiated on *Psectrosciara brevicornis* Johannsen. In some scatopsids from other regions, the apical portion of the antenna is often distinctly annulated. The eyes of both sexes come together on top of the head above the antennae, much as in the Sciaridae and the Lestremiinae (Cecidomyiidae). The legs are short and robust. The abdomen is usually very broad and expanded posteriorly as seen in dorsal view. The conjunctiva of the abdomen is densely covered with microscopic longitudinal striae.

The immature stages are found in decaying organic matter and are often found breeding in manure. They are seen commonly on windows and at lights.

Previous to the recent works of Dr. Edwin F. Cook, University of Minnesota (1955; 1956), the only revisional studies of the family were those by Duda (1929), Melander (1916), and Enderlein (1912b). In the latter paper Enderlein separated the family from Bibionidae (see also Enderlein, 1911:122) and erected seven new genera based upon wing characters. The characters he used were completely useless and most of these genera were unrecognizable and were synonymized with *Scatopse* by Duda (1929) and Edwards (1925). Cook has restudied the genotypes and has found most of Enderlein's genera to be valid. He has revised much of the generic classification of this family, has completed monographs on several of the groups, and has placed their taxonomy upon a much more firm foundation. The generic characters which Cook uses are as follows: presence or absence of specific setae on the wings and thorax; the structure of the male and female genitalia; the structures of the abdominal segments; the development of the thorax, including size and shape of the anterior spiracular sclerite; and the wing venation. It is obvious that wing characters alone cannot be wholly relied upon to separate genera but must be supplemented by other structural details.

The biology and immature stages of these flies have received little attention and are practically unknown. Just a few species of *Scatopse sens. lat.* (Scatopsinae) and one *Canthyloscelis* (Corynoscelinae) have been studied (see Beekey, 1938:151; Hennig, 1948:90; and Tonnoir, 1926 and 1927). Edwards (1930:97) reported collecting *Rhegmoclemina constricta* (Edwards) (as *Scatopse*) in "rotten log with termites." Muller (1919:120) reported that *Swammerdamella brevicornis* (Meigen) and *Scatopse femoralis* Meigen may be parasites of phorid pupae. Cook (1956b:15) questions this record, and it is probable that Muller's flies were scavengers. The larvae of Scatopsinae (at least of *Scatopse sens. lat.*) are fusiform, subcylindrical, dirty white to brownish, and range in size from about 2.5 to 5.0 mm. The head is prognathus, the mandibles are opposed, and the antennae are short and two-

segmented. A pair of spiracles is present on the prothorax; these are borne on short stalks on some species while in others they may be sessil. On *Scatopse fuscipes* Meigen they are borne on slight elevations. The abdomen is nine-segmented with spiracles on the sides of the first eight segments; those on segments 1 to 7 are small and may be slightly elevated, while those on segment 8 are situated on two widely divergent stalk-like appendages which are at least half as long as the segment. The apical portion of the body has a pair of slender sclerotized appendages near hind margin. Some species have one or more lateral protuberances on each abdominal segment.

For information on the larvae see Hennig (1948:90–91); Peterson (1951:250, 274); Tonnoir (1926:353–356; 1927:291–300); and Malloch (1917:300–302).

Just four species are known in our fauna, only one of which has previously been recorded; these fit in four different genera. All also occur in Micronesia (see Hardy, 1957a).

Key to the Genera and Species of Scatopsidae in Hawaii

1. Head higher than long (fig. 61a). Abdomen not conspicuously elongated, narrowed at base and expanded posteriorly. Antennae 10-segmented, counting the terminal portion as one segment. Vein Cu_2 curved down sharply toward hind margin of wing (fig. 61b) 2

   Head and abdomen elongate, the former nearly two times longer than high (fig. 59a); the latter not clavate in shape and one and one-half to two times longer than the head plus the thorax. Antennae nine-segmented (fig. 59b). Vein Cu_2 not sharply curved downward (fig. 59d) .... **Psectrosciara brevicornis** Johannsen.

2. Second section of costa (from apex of R_1 to R_{4+5}) about equal in length to the first section (from humeral crossvein to R_1). Stem of M_{1+2} about half as long as M_2 (fig. 61b). Larger species, 1.5–1.8 mm 3

   Second section of costa very short, not half as long as first; stem of M_{1+2} less than one-fourth as long as M_2 (fig. 60a). Small species, 1.0 mm.... **Rhegmoclemina parvula** Hardy.

3. A portion of r–m crossvein present as a dorsal appendage near base of M_1. R_{4+5} ends near apical three-fifths of wing (fig. 58a). Tarsi all yellow......................... .... **Holoplagia guamensis** (Johannsen).

   Crossvein r–m entirely lacking. Vein R_{4+5} ends near middle of wing (fig. 61b). Tarsi discolored with brown above.... .... **Scatopse fuscipes** Meigen.

Genus **HOLOPLAGIA** Enderlein

Holoplagia Enderlein, 1912, Zool. Anz. 40:267.

This has been previously synonymized with *Scatopse* but Dr. Cook states that it is a valid genus (see Cook, 1956d:610). It is separated from other scatopsids by having the wings densely covered with macrotrichia; by lacking setae on vein Cu_2; by having the antennae longer than the head height and 10-segmented; by having setae on the stems of the halteres; by having the thorax broad and rather stout; and by having at least a portion (usually a complete crossvein) of r–m crossvein present (fig. 58a). Refer to Cook for further details.

Type of genus: *Holoplagia transversalis* Enderlein (*nec* Loew) = *H. lucifuga* (Loew).

Only one species present in Hawaii.

Holoplagia guamensis (Johannsen) (figs. 58a–e).

Scatopse guamensis Johannsen, 1946, B. P. Bishop Mus. Bull. 189:187.

Holoplagia guamensis (Johannsen), Cook, 1956, Ann. Ent. Soc. Amer. 49(6):610.

Oahu (rather common in the lowland and probably present on other islands).

Immigrant. Known previously only from Guam (type locality: Piti). Dr. E. F. Cook has informed me that this is a very widespread species. He has studied specimens from Truk, Panama, and Accra, West Africa. I also have seen specimens from several localities in the Mariana and Caroline Islands.

Type in Cornell University collection. I have compared specimens with the type.

This fits close to *Scatopse albitarsis* Zetterstedt and runs to that species in Duda's key to the Palaearctic species (1929:10); the wing venation and most other details fit very closely, but the male genitalia are very different. Johannsen's "figure F" and description of the wing of *guamensis* are very misleading. He possibly drew and described the wing of a specimen of *S. fuscipes*, not *guamensis*. His other figures are correct, however. I have studied the type series in the collections of Cornell University and Hawaiian Sugar Planters' Association but did not find a specimen which fit Johannsen's wing figure.

This species is distinguished from all other known species of *Holoplagia* by the all-yellow tarsi, the wing venation (fig. 58a), and the genitalia of both sexes (figs. 58b and 58d). In the specimens which I have examined, the r–m crossvein is represented by an appendix extending slightly over half-way between M_1 and R_{4+5}. The r–m crossvein may be complete in some specimens (see Cook, 1956d:607, fig. K). The portion of M_1 beyond the r–m is gently arcuate. Vein M_{3+4} curves upward sharply in outer third of the wing but evanesces before reaching the margin. Vein Cu_2 curves downward sharply to the wing margin. The costa and the apex of vein R_{4+5} end at about the apical three-fifths of the wing (fig. 58a). The genitalia of both sexes are very distinctive (figs. 58b, 58d, and 58e). The seventh (visible) sternum of the male is evenly concave on the hind margin; the bottom of the concavity is almost flat. The hind margin of the seventh tergum is not produced. The penis is short and terminates in a thickened apex. A pair of well-developed claspers are present (fig. 58b). In the female, the hind margin of the seventh sternum is gently concave and the eighth sternum has a rather strong slender lobe on each posterior lateral margin and a small V-shaped

concavity in middle of hind margin (fig. 58e). The seventh tergum has a narrow V-shaped cleft in middle of hind margin (fig. 58d).

Length of male: body, 1.25–1.5 mm.; wings, 1.1–1.25 mm.

Length of female: body, 1.5–1.75 mm.; wings, 1.2–1.3 mm.

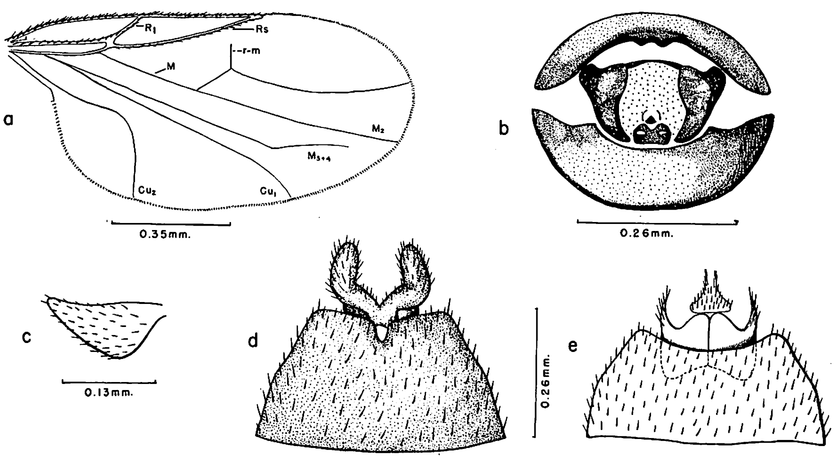

Figure 58—*Holoplagia guamensis* (Johannsen): **a,** wing; **b,** male genitalia, end view; **c,** palpus; **d,** female genitalia, dorsal view; **e,** female genitalia, ventral view.

Genus **PSECTROSCIARA** Kieffer

Psectrosciara Kieffer, 1912, Trans. Linn. Soc. Lond. 15:192.

A very characteristic group recognized by the elongate head; slender, linear abdomen; and the wing venation (fig. 59d). The head is one and one-half to two times longer than high and the portion behind the eye is equal or longer than the eye (fig. 59a). The abdomen is nearly two times longer than the head plus the thorax. The elongate costa, the long second costal section, and the gently curved vein Cu_2 are distinctive. The costa extends to about the apical three-fourths of the wing. The second section of the costa (that portion from apex of R_1 to apex of R_{4+5}) is two times longer than the first (from humeral crossvein to tip of R_1). I find no evidence of vein M_{3+4} in the specimens I have studied.

Type of genus: *Psectrosciara mahensis* Kieffer.

Psectrosciara brevicornis Johannsen (figs. 59a–d).

Psectrosciara brevicornis Johannsen, 1946, B. P. Bishop Mus. Bull. 189:188.

Oahu and Maui (probably on other islands also).

Immigrant. Known previously only from Guam (type locality: Sumay).

Type in the Cornell University collection.

I have compared specimens with a paratype in the Hawaiian Sugar Planters' Association collection.

The genus and species in Hawaii is characterized by its elongate head (fig. 59a) and body and distinctive wing venation (fig. 59d). Johannsen allied it to *P. mahensis* Kieffer (a synonym of *P. brunnescens* (Brunetti) according to Edwards, 1927:120) from the Seychelles and separated it by the "nine instead of ten antennal segments, and a distinctly shorter terminal segment." Kiefler, in the original description of *P. mahensis* (1912:192), said that the antenna is 16-segmented. Enderlein (1912:280) corrected this to 10. The apical segment is three times longer than the penultimate in *mahensis*, but Kieffer does not compare its length to its width. Enderlein says the last is very long and, by his comparison with *P. scatopsiformis* Enderlein, one would assume it to be about three times longer than wide. In *brevicornis* the last segment is about one-third longer than wide (fig. 59b). It also seems related to *P. californica* (Cole) but has the vertical portion of Rs (appearing as a short crossvein between R_1 and R_{4+5}) situated about half-way between the humeral crossvein and the apex of R_1, rather than near the basal one-fifth of this section. Johannsen, and also Bohart and Gressitt (1951:62, fig. C), show the base of M_1 distinct; the description says it is distinct although weak. I find it very difficult to see on our specimens. The head, thorax, and abdomen are predominantly dark brown to black and the posterior portions of the abdominal segments are sometimes pale brown to yellowish. The palpi each have a large sensory structure at the apex and another near middle of inner margin (fig. 59c). The subcostal and radial veins are black, the others are hyaline. Vein R_{4+5} enters the costa at about the apical two-thirds to three-fourths of the wing and vein Cu_2 is gently curved downward (fig. 59d).

Length: body and wings, 1.5 mm.

The species is known only from the females. I have seen but six specimens from Hawaii: one from Koko Head, 1927; one from Kawela Bay, 1934; one from Ewa, 1935; three from windows at Honolulu, 1939–1952 (all on Oahu); and one from Lahaina, Maui, December, 1928.

Johannsen treated this species under the family Sciaridae.

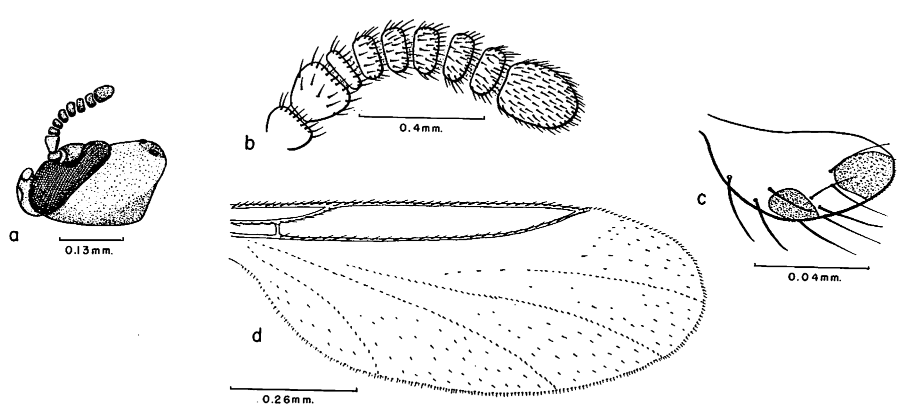

Figure 59—*Psectrosciara brevicornis* Johannsen: **a,** head, lateral view; **b,** antenna; **c,** palpus; **d,** wing.

Genus **RHEGMOCLEMINA** Enderlein

Rhegmoclemina Enderlein, 1936, Die Tierwelt Mitteleur., Bd. 6, Lief. 2, Insekt. 3, p. 55.

Dr. E. F. Cook (1955b:351–354) has revised this genus and points out that it is closely related to *Rhegmoclema* Enderlein and *Parascatopse* Cook because of the following characters: "Maxillary palpi short and somewhat ovoid in form [;] vein Cu_2 bearing at least a few macrosetae [and with] two right angled bends along its course [;] pedicel of haltere without macrosetae [;] females with 8 pairs of abdominal spiracles [and] female terminalia with but a single pair of appendages (probably cerci) articulated to tergite 8 or fused to tergite 8; in the latter case tergite 8 longitudinally divided and the tergite and cerci simulating the cerci and appearing to articulate to segment 7 (*Rhegmoclema*)." *Rhegmoclemina* is differentiated from the other two genera by having "no macrosetae on M_1 or M_2; M_1 always complete [;] seventh sternite of the males distinctly shield-shaped [and] a more or less distinct row of supraalar setae" present; and the anterior spiracular sclerite triangular.

Type of genus: *Scatopse vaginata* Lundström.

Only one species present in the Hawaiian fauna.

Rhegmoclemina parvula Hardy (figs. 60a–d).

Rhegmoclemina parvula Hardy, 1957, Insects of Micronesia. Diptera: Bibionidae and Scatopsidae. B. P. Bishop Mus. Ins. Micron. 12(2):96.

Oahu. Known in Hawaii only from one specimen taken in Waikiki, Honolulu, May 30, 1919 (J. C. Bridwell).

Immigrant. Caroline Islands (type locality: southwest Koror). Possibly widespread in the Pacific region.

Type in the U.S. National Museum.

From the literature, this species cannot be differentiated from *R. willistoni* (McAtee) (change of name for *Scatopse pygmaea* Williston, 1896, *nec S. pygmaea* Loew, 1864) except that it is apparently about half the size of that species (1.0 mm. vs. "2.0 mm."). Dr. Cook has informed me that there are two North American and at least two or three Central American and Caribbean species which have identical wing venation and which fit Williston's description of *pygmaea* (West Indies). Until Williston's type is studied it is impossible to state just how the Pacific species might differ.

A very tiny, chiefly dark brown to black species, easily differentiated from all other scatopsids known from the Pacific by its wing venation, small size, and pale-colored tibiae. The wings are hyaline, the costa ends slightly before the middle of the wing. The second section of the costa is about one-third as long as the first. Vein M_{1+2} is very short, about one-fourth as long as M_2. Cell M_1 is distinctly narrowed in the median portion by the curvatures of veins M_1 and M_2. Veins M_{3+4}, Cu_1, and Cu_2 evanesce before reaching the wing margin and vein Cu_2 is strongly sinuate (fig. 60a). The anterior spiracular plate is as in figure 60d.

The femora are brownish yellow. The tibiae are yellow with a narrow ring of brown near bases. The tarsi are all yellow. The abdomen is about one-half longer than wide, dull brown on the dorsum, with the hind margins of the apical segments brownish yellow, and tinged with rufous on the venter. The genitalia are yellow. In the female the sclerites of the seventh segment are straight on their hind margins. The eighth segment is reduced to a very narrow ring extending over the dorsum. A pair of well-developed, triangular-shaped plates extend around the anal region (fig. 60b). The sternum has a pair of shorter, rectangular-shaped sclerites (fig. 60c). The male genitalia have not been studied.

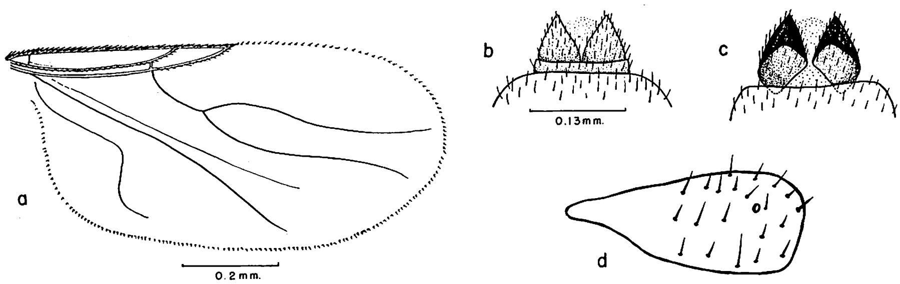

Figure 60—*Rhegmoclemina parvula* Hardy: **a,** wing; **b,** female genitalia, dorsal view, **c,** female genitalia, ventral view; **d,** anterior spiracular plate.

Genus **SCATOPSE** Geoffroy

Scatopse Geoffroy, 1762, Hist. des Insectes 2:450.
Scathopse Geoffroy, 1762, Hist. des Insectes 2:544.
[?] *Ceria* Scopoli, 1763, Ent. Carn., p. 351.
Reichertella Enderlein, 1912, Zool. Anz. 40:268.
Coboldia Melander, 1916, State Col. Wash. Agr. Expt. Sta. Bull. 130:17.
Rhaeboza Enderlein, 1936, Die Tierwelt Mitteleur. 6, Ins. 3:55.
Massatierra Enderlein, 1938, in Skottsberg's, Nat. Hist. Juan Fernandez and Easter Is., 3 (Zoology):666.
Synonymy from Cook (1956d:594).

This genus is differentiated by its comparatively short body and head and by the abdomen, which is usually clavate in shape as seen from above. At least a remnant of the r–m crossvein is sometimes present. The antennae have 10 well-defined segments. A portion of the r–m crossvein may be present as an appendage on the upper side of the vein M_1 or it may be lacking. The wings have no macrochaetae on the veins or membrane and vein Cu_2 is arcuate. Also tergum 7 of the male is produced in our species (fig. 61d) and the female has no paired appendages on the genitalia.

The males of species which I have studied have just six abdominal segments before the genital portion, although Cook (1956d:596) says "There are seven

obvious pregenital segments." The seventh visible segment is probably made up of the combined seventh and eighth segments and forms a protective capsule in which lie the genitalia. The shape and development of the sclerites making up this seventh (visible) segment are important in separating species. The genitalia, to my knowledge, have not been carefully studied and it is extremely difficult to associate the structures correctly aside from the aedeagus and its parts, the cerci, and the anal region. The ninth segment is reduced sometimes to a rather narrow ring, and claspers (clasper-like structures) are fairly well-developed. The penis is large and highly modified. Refer to Cook (1956d:596) for further morphological and taxonomical details of this genus.

There is danger of the name *Scatopse* (as well as some other well-established generic names of Diptera) being invalidated because of the decision of the International Commission on Zoological Nomenclature at the Paris Congress to substitute the word "binomial" for the word "binary" in the Code. Since the generic names of Geoffroy were not proposed in binomial combinations this ruling would necessitate their being discarded even though they have been used commonly throughout entomological literature dating back to Linnaeus' time. Stone and others (1954) have requested the Commission to use its plenary powers to preserve the generic names of Geoffroy by placing them on the Official List of Generic Names in Zoology. They have also requested that the name *Scathopse* Geoffroy (1762:544), an incorrect spelling of the name *Scatopse* Geoffroy (1762:450), be placed on the Official Index of Rejected and Invalid Generic Names in Zoology. They also point out that the Geoffroy names have often been cited in the literature as dating from 1764; they were actually first published in 1762.

Type of genus: *Tipula notata* Linnaeus.

Scatopse fuscipes Meigen (figs. 61a–f).

Scatopse fuscipes Meigen, 1830, Syst. Beschr. Europ. Zweifl. Ins. 6:314.

The status of the name *fuscipes* is somewhat questionable; it is possible that it may be a synonym of *Scatopse atrata* Say. Duda (1929:21–22) treats *Scatopse atrata* Wiedemann, 1828 (*nec* Say) as a synonym of *S. fuscipes* and lists *S. atrata* Say as a *sp. incerta* probably not the same as *fuscipes* but from the description possibly fitting in the genus *Ectaetia* Enderlein. Cook, in correspondence, says: "Loew in 1864 stated that from personal knowledge *S. recurva* Loew was a synonym of *S. atrata* Say. Kertesz, Edwards and Duda (who saw types) all indicated that *recurva* Loew is a synonym of *fuscipes*. From this I would conclude that *S. atrata* Say is the valid name. The idea that *atrata* might be an *Ectaetia* originated with Edwards. But I think Edwards was misled by Say's statement that there were two veins between M_2 and the 'undulant vein' (Cu_2). I think Say mistook the fold between M_2 and Cu_1 for a vein. At any rate, *Ectaetias* are very uncommon and I know of none taken at windows where Say indicated his were taken. *S. fuscipes* is most commonly taken in such places." Since Say's type is lost and his species cannot be definitely recognized from his description, it is perhaps best to ignore it and to use the name *fuscipes*, which has been in common usage for the past 25 years. *Scatopse fuscipes* is the genotype of *Rhaeboza* Ender-

lein. This was based only upon the amount of curvature of the anal vein and the character is not of generic importance.

For synonymy see Duda (1929:21–22) and Cook (1956d:608).

Oahu, Hawaii, and probably generally spread over the lowlands on all of the islands.

Immigrant. Cosmopolitan. This is probably the species which Bridwell (1920:284) reported as a "bibionid fly" probably belonging to "*Scatopsis*" (misspelling for *Scatopse*). It was recorded by Bryan (1934:406) under the name *Rhegmoclema atrata* Say "captured in a parasite cage from California in 1915" but not known to be established. The first definite record of the species being established here is that of Wirth (1947:7).

This species is very common in the lowlands. It breeds in all sorts of decaying organic matter.

It is easily recognized by its 10-segmented antennae (fig. 61a), by vein R_{4+5} entering the costa just beyond the middle of wing, and by vein M_1, which is not strongly arched and lacks an appendix (remnant of r–m crossvein not present) (fig. 61b). The legs are largely black, the tarsi are yellow discolored with brown above. The genitalia of both sexes are very characteristic (figs. 61d and 61f).

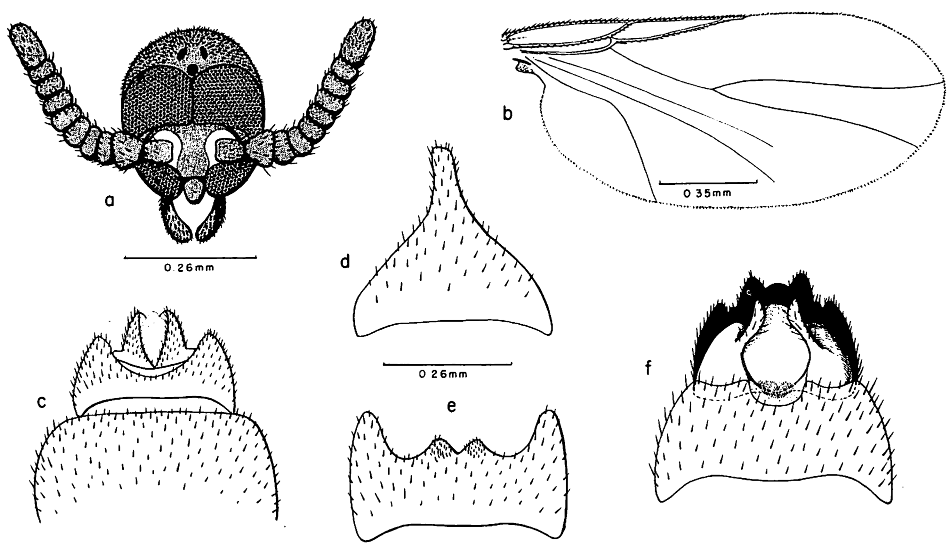

Figure 61—*Scatopse fuscipes* Meigen: **a,** head, front view; **b,** wing; **c,** female genitalia, dorsal view; **d,** seventh tergum of male; **e,** seventh sternum of male; **f,** female genitalia, ventral view.

In the male the seventh (visible) sternum has a small V-shaped cleft in middle of hind margin and a rather well-developed lobe on each posterior lateral margin (fig. 61e). The seventh (visible) tergum has a well-developed symmetrical median projection from the hind margin (fig. 61d). Cole (1927:418) suggests that this is a joining of two lobes. The penis is elongate and coiled. The seventh sternum

of the female has a broadly U-shaped concavity in the middle of the hind margin (fig. 61f); the hind margin of the seventh tergum is straight while the apex of the eighth tergum is gently concave (fig. 61c). The eighth sternum has a pair of submedian lobes as in figure 61f. Refer to Cook (1956d:608) for more detailed information on this species.

Length of males: body, 1.34–2.1 mm.; wings, 1.3–2.0 mm.

Length of females: body, 1.7–2.4 mm.; wings, 1.4–1.86 mm.

Family MYCETOPHILIDAE Newman
The Fungus Gnats

Mycetophilites Newman, 1834, Ent. Mag. 2:386.
Mycetophilidae Macquart, 1838, Dipt. Exot. nouv. ou peu Connus 1(1):76.
Mycetophilinae Zetterstedt, 1838, Insecta Lapponica 3, Diptera, p. 853.
Mycetophilides Westwood, 1840, Intro. to Modern Class. Ins. 2:521.
Fungivoridae Speiser, 1910, in Sjostedt's, Wissensch. Ergebnisse der Schwedischen Zoologischen Exped. Kilimandjaro, 2(10): 35.
For more complete synonymy see Handlirsch, in Schröder (1925:954).

The name comes from the Greek mykes, mushroom, fungus, + philios, loving.

The members of this family in Hawaii are moderately small, dark-colored flies characterized by their elongate coxae, by the absence of cell 1st M_2 (discal) in the wing (fig. 62), by the lack of a complete transverse suture on the mesonotum or of a midpleural pit, and by the presence of spurs on the tibiae. In many respects they are similar to the Sciaridae, but can be differentiated because the eyes are separated on the front, the midpleural pit is absent (in Hawaiian species), and the wing venation (figs. 63b and 65b) and development of the antennae, and the palpi are characteristic (figs. 65a and 65g). Many workers have considered the Sciaridae as a subfamily of Mycetophilidae, but Shaw (1948:192 and 1952:20) has pointed out that while this group is obviously of mycetophilid stock it should be considered a distinct family because of the presence of a midpleural pit, the general shape of the katepisternum, the apparent lack of a meron, and the presence of a distinct precoxal bridge.

The head is small and the eyes round. The flagellar segments of the antennae are broad and flattened, especially in the males. In the Hawaiian species the palpi have three well-developed segments with the last segment elongated (fig. 65a); just two ocelli are present. For information on the details of the thoracic sclerites, refer to the works of Shaw (1948 and 1951). The mesonotum is moderately arched, the scutellum is small, and the metanotum is rather elongated (about equal in length to the 1st abdominal segment). The legs are long and slender and tibial spurs are well developed (fig. 64c). The wings are often infuscated in our species. The subcostal vein may be well developed and extending to wing margin or it may be rudimentary (fig. 66b). Vein R_4 is present in some species and is fused with R_5 (or lacking) in others (figs. 63b and 65b). The abdomen is slender and rather club-shaped, especially in the males. In the females the segments are rather broad and the abdomen is flattened dorsoventrally. The

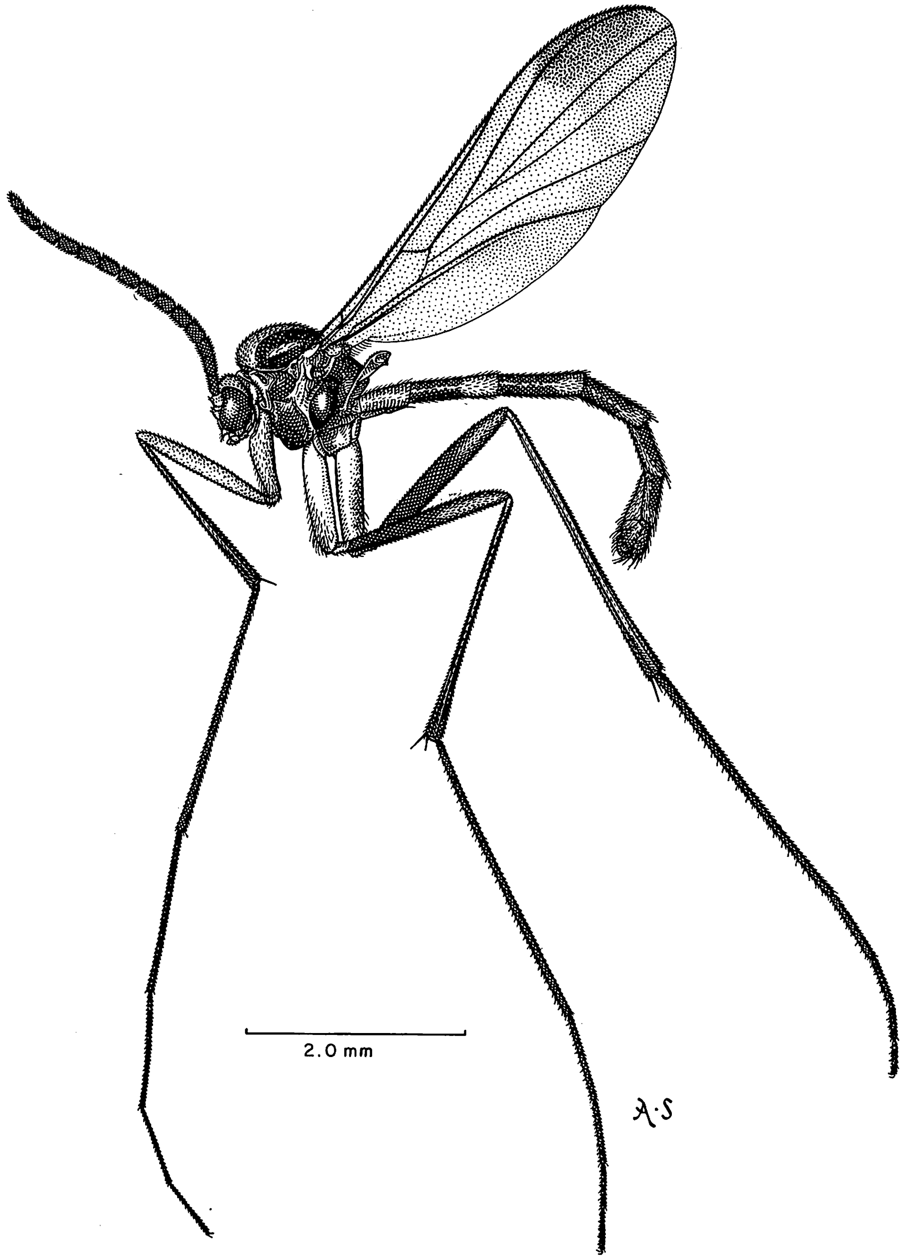

Figure 62—*Orfelia* (*Tylparua*) *hawaiiensis* (Grimshaw). Adult male.

basistyli of the genitalia are usually separated basally on the ventral surface by a membranous area or a distinct furrow, and the dististyli are usually rather small

and sharp-pointed (figs. 63e and 65c). The cerci are elongate and slender. The ninth tergum is very broad and expanded and extends about to apices of the dististyli (figs. 64d and 65e) except in the subgenus *Trigemma*.

The adults of the fungus gnats are found in moist, dark habitats, usually in association with decaying plant material and dense vegetation. These flies are rather uncommon in Hawaii and are found only in the wet areas in the mountains. Nothing is known about the habits of our species and the immature stages are completely unknown. The larvae of mycetophilids are known to be slender, vermiform, and subcylindrical, usually whitish or yellowish in color. The head is small, heavily sclerotized, and black or brown in color. They usually have one pair of spiracles on the thorax and seven on the abdomen. Shaw and Fisher (1952:177) says spiracles are lacking in the genus *Platyura* "though anal gills have been observed." It is probable that the larvae of all of our species are terrestrial and live in association with decaying plant materials.

Just a single genus, *Orfelia* A. Costa, with two subgenera is known from Hawaii. Five species are known to date; all are endemic. In most of the literature the subfamily to which our genus belongs has been spelled Ceroplatinae. This has been corrected to Keroplatinae by Paul Freeman (1951:12). The original spelling of the genus upon which the subfamily name is based, was *Keroplatus* (Bosc, 1792, Act. Soc. Hist. Nat. Paris 1:42). This was emended to *Ceroplatus* by Fabricius (1798, Ent. Syst. Suppl., p. 550). Freeman feels that the emendation was incorrect and that the original spelling of Bosc should be retained.

Edwards (1929a:163) defined this genus (as *Platyura*) as including "all members of the Ceroplatinae which possess the following combination of characters: Palpi incurved, slender, of three distinct segments. Labium well preserved, but always shorter than head, labella large. Antennae 16-segmented, shorter than body, cylindrical or somewhat flattened, not broadly flattened (as in *Ceroplatus*) nor pectinate (as in *Platyroptilon*). Tarsi and usually tibiae with small spiny bristles; no empodia; hind tibia with outer and inner apical combs, and at least one long spur. Wings without macrotrichia on membrane; media and radius fused for a shorter or longer distance; no trace of fold-like basal portion of media." According to Shaw and Fisher (1952:185) *Orfelia* (as *Zelmira*) separates from *Platyura* (*sens. str.*—the group which has been known under the generic name *Apemon* Johannsen) by having the "base of M indistinguishable," rather than "base of M evident or represented by a fold." Most of our species fit in the subgenus *Tylparua* Edwards; one species apparently represents a new subgenus. For a monograph of the genus and the setting up of the subgenera refer to Edwards (1929a). It is interesting to note that most of Edwards' nineteen subgeneric names were anagrams of *Platyura* and now none of these is under *Platyura*.

Genus **ORFELIA** A. Costa

Zelmira Meigen, 1800, Nouv. Class., p. 16. Rejected name.
Orfelia A. Costa, 1857, Il Giambattista Vico, Giornale Scientifico, Naples 2:448.

Platyura of most authors, but not of Meigen, 1803, Illig. Mag. fur Insekten. 2:264.

Stone (1941:415) pointed out that *Platyura* Meigen, 1803 (based upon the genotype *P. marginata* Meigen), is generically distinct from *Zelmira* Meigen, 1800 (based upon the genotye *Platyura fasciata* Meigen), and *Apemon* Johannsen, 1909, is a synonym of *Platyura* Meigen. The *Platyura* of most authors (including the usage in the previous Hawaiian literature) is synonymous with *Zelmira* Meigen. If the Commission rules that the Meigen 1800 names are to be rejected, the name *Zelmira* would not be available and the next name for this genus is apparently *Orfelia* A. Costa.

According to Shaw and Fisher (1952:185), members of this genus are distinguished from other Keroplatinae by having the base of M indistinguishable, the maxillary palpi normal (not porrect) and with three or four distinct segments, and mouthparts not greatly elongated.

Type of genus: *Platyura fasciata* Meigen, by present designation.

Key to Subgenera and Species of Orfelia in Hawaii

1. Only two ocelli present. Middle and hind tibiae each with two well-developed spurs. Each tibia with about six rows of setulae which are much more closely set than are the others and which appear as conspicuous black lines. Subgenus **Tylparua** Edwards 2
   Three ocelli present. Each tibia with but a single spur. All rows of tibial setulae alike. **Trigemma** n. sub. gen. .... **infurcata** n. sp.
2. Second anal vein very weak, represented by only a rudiment at base of wing (fig. 65d). Costal margin not brown fumose 3
   Second anal vein well developed, extending at least to a level with the m–cu crossvein. Costal margin brown fumose (fig. 64b) 4
3. Sc incomplete (fig. 66b), not extending to costa, or greatly weakened on apical portion. Wings rather evenly but lightly infuscated. Mesonotum predominantly rufous, discolored with brown to black. Flagellar segments of male antennae about as wide as long (fig. 66a) .... **insularis** (Grimshaw).
   Sc complete, extending to costa. Apical one-fourth to one-third of wing more darkly infuscated than remainder of wing (fig. 65d). Mesonotum typically reddish yellow with a broad, shining black stripe down each side. Flagellar segments two times longer than wide (fig. 65g) .... **hawaiiensis** (Grimshaw).

4. Vein R_4 absent. Second anal vein extending well beyond the level of the m–cu crossvein (fig. 64b)....**cratericola** n. sp.
   Vein R_4 present. Second anal vein ending about opposite the m–cu crossvein (fig. 65b).......**fuscocostata** (Grimshaw).

Subgenus TRIGEMMA, new subgenus

One Hawaiian species fits near *Orfelia* (*Laurypta*) Edwards from the Malay Peninsula, Ceylon, and the Seychelle Islands. It differs, however, by lacking vein R_4; by having the mesopleura setulose; by having the section of the costa from the tip of R_1 to R_5 much shorter (about two-thirds as long) than that section from apex of Sc to R_1 and the portion of costa beyond tip of R_5 more elongate, extending about three-fourths the distance to vein M_1 (fig. 63b); and by having longitudinal bare strips on the mesonotum, rather than having the mesonotum uniformly setulose. Also the male genitalia are probably very different.

The group differs from other mycetophilids in the Hawaiian fauna by having three ocelli, a single spur on each tibia, setulose metanotum and mesopleura, and all of the rows of tibial setulae alike, not with some rows more closely set and conspicuously differentiated from the others. Also the second anal vein appears to be completely lacking in *Trigemma*.

Type of subgenus: *Orfelia* (*Trigemma*) *infurcata* n. sp.

Orfelia (Trigemma) infurcata, new species (figs. 63a–e).

This differs from all known species of *Orfelia* by the characters given under the subgeneric discussion above.

MALE. A small, slender, predominantly dark-colored species. *Head:* Entirely dark brown to black. Three prominent ocelli present. Epistome moderately produced and with rather numerous short black setae. Palpi brown, last segment about equal in length to remainder of palpus. Antennae brown to black, just a little longer than the thorax; attenuated portion of basal flagellar segment yellow; scape and pedicel tinged with yellow. Flagellum 14-segmented, most of the segments about as wide as long (fig. 63a); apical flagellar segment about two times longer than wide. *Thorax:* Entirely brown to black except for the yellow humeral ridges and the yellow conjunctiva between the sclerites of the pleura. Mesonotum rather thickly black setulose but with a bare strip inside each dorsocentral row (between the dorsocentral and acrostichal setae) and another broader bare strip between the dorsocentral and supraalar setae on the posterior half of the mesonotum. Dorsal surface of metanotum thickly setulose, sides bare. Upper portion of each mesopleuron (anepisternum) thickly covered with short black setae. Stems of halteres yellow, knobs brown. *Legs:* Coxae brown; femora yellow, tinged lightly with brown; the tibiae and tarsi brown to black. Each middle and hind tibia with a single, rather long, spur. *Wings:* Rather evenly infuscated. Sc complete, ending in the costa before the base of Rs. Vein R_5 straight, entering the costa well before the wing apex so that the section of costa between the tips of

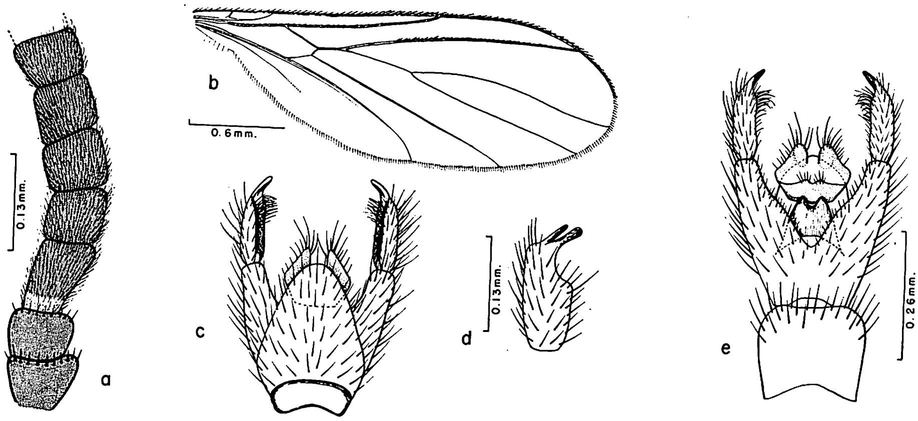

Figure 63—*Orfelia* (*Trigemma*) *infurcata* n.sp.: **a,** basal portion of antenna; **b,** wing; **c,** male genitalia, dorsal view; **d,** male dististylus; **e,** male genitalia, ventral view.

R_5 and R_1 is short compared to that section from R_1 to Sc; the free portion of the costa beyond the tip of R_5 is rather elongate, extending about three-fourths the distance to M_1 and making cell R_5 appear unusually broad as shown in figure 63b. The junction of veins Rs and M_{1+2} is about two-thirds as long as the base of Rs and the free portion of M_{1+2} is about half as long as M_2. The 2nd anal vein seems to be completely lacking and is represented only by a slight longitudinal folding in that area of the wing. *Abdomen:* Entirely brown to black, slender, sides nearly parallel; thickly covered with black setae. Basistyli joined in the middle, separated by a broad V-shaped cleft. Dististyli well developed, about two-thirds as long as basistyli (fig. 63e), bipronged at apex (fig. 63d) and hollowed out and thickly haired on inner surface. Ninth tergum small compared to other Hawaiian *Orfelia*, extending only to about the apices of the basistyli (fig. 63c). The cerci are large and rather well developed. Immediately above and between the basistyli is a well-developed sclerotized plate which has a U-shaped concavity on its hind margin (fig. 63e), this is evidently part of the aedeagus.

Length: body, 3.55 mm.; wings, 2.8 mm.

FEMALE. Similar in most respects to the male. Antennae short, about two-thirds to three-fourths as long as the thorax, the two basal segments yellow. The abdomen is much broader, and the basal four or five segments are tinged with yellow in the ground color.

Holotype male, allotype female, and 13 paratypes (7 males and 6 females): from Puu Kokekole, Molokai, 3,600 ft., July, 1953 (D. E. Hardy and M. Tamashiro). Also 3 paratype females, one each from the following localities: Alakai Swamp, Kauai, 3,800 ft., July, 1952 (D. E. Hardy); Mt. Waialeale Trail, Kauai, 4,500 ft., August, 1953 (D. E. Hardy); and Honomanu, Maui, June 23, 1920 (E. H. Bryan, Jr.).

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. The

remainder in the following collections: U.S. National Museum, British Museum (Natural History), Hawaiian Sugar Planters' Association, and the University of Hawaii.

This species has been taken only in very wet areas in the mountains.

Subgenus **TYLPARUA** Edwards

Platyura (*Tylparua*) Edwards, 1929, Proc. Linn. Soc. N. S. Wales 54(3):172.

This subgenus apparently differs from the typical subgenus ("*Platyura*" of Edwards) by lacking the median ocellus and by having the metanotum bare or nearly so; the anal vein is rather poorly developed, except in *cratericola* n. sp., and the antennal pubescence is rather long.

This subgenus is definitely known only from Hawaii although Edwards (1929a) says that "*P. funerea* Brunetti" from India also lacks the median ocellus and may belong here.

Type of subgenus: *Platyura hawaiiensis* Grimshaw.

Orfelia (Tylparua) cratericola, new species (figs. 64a–d).

This species is readily differentiated from other known *Orfelia* (*Tylparua*) by the well-developed anal vein and lack of vein R_4 as well as by the body coloration, the development of the male antennae (fig. 64a), and the male genital characters (fig. 64d). It is closest to *O. fuscocostata* (Grimshaw) and is differentiated by the above characters.

MALE. *Head:* Subshining black, rather densely covered with black hairs on the occiput and on the vertex. The eyes are densely brown to black pilose; the palpi are dark brown to black, tinged with yellowish on the basal segments. The apical segment of each palpus is about equal to the combined lengths of the two preceding segments. The face has a dense mystax of black hairs on the oral margin and is indistinctly gray pollinose. The labella are yellow-brown. The basal segment of the antenna is dark brown to black; the apical portion of the pedicel is yellowish; the flagellar segments are chiefly black; the first two are tinged with yellow. The first flagellar segment is nearly two times longer than wide and is strongly narrowed at the basal portion. The second segment is about as wide as long; the remainder, except for those at the apex, are broader than long (fig. 64a). *Thorax:* Mesonotum chiefly subshining black; yellow behind the humeri and on the lateral margins, rather thickly black haired especially along the sides. The prothorax, with the exception of the black epimera, is entirely yellow. The scutellum and the parascutellum are also yellow; the remainder of the pleura are brown to black, faintly tinged with yellow. The metanotum and the knobs of the halteres are black, the stems of the halteres are yellowish. *Legs:* Predominantly yellow; the trochanters and tarsi and the bases of the femora and apices of the tibiae are brown to black. The basitarsi are approximately equal in length to the remainder of the tarsal subsegments. *Wings:* The costal cell, to the humeral crossvein, is hyaline, the costal margin beyond that point is dark brown fumose; this fumosity becomes

somewhat lighter toward the apical portion of the wing and no distinct costal band is discernible. The remainder of the wing is light brown fumose. The subcostal vein enters the wing margin at a point about opposite the forking of the radial sector. The costa extends about half way between the tips of veins R_5 and M_1. The fusion of the media and radius is less than the length of the free portion of the radial sector and is about two-fifths to one-half as long as M_{1+2}. Vein R_4 is lacking and cell R_3 is relatively broad. The anal vein is well developed and extends three-fourths to four-fifths the distance to the wing margin. The subcostal cell has a longitudinal fold which simulates a fork of the subcostal vein (fig. 64b). *Abdomen:* Chiefly dark brown to black; indistinctly yellow to rufous on the bases of segments 3 to 5. The entire abdomen is densely covered with short black hairs. *Genitalia:* About equal in length to the sixth abdominal segment, dark yellow-brown to black in color, and densely black haired. The ninth tergum is one-half longer than wide and has a distinct concavity on the posterior margin. The eighth tergum is expanded on the sides with a narrow sclerotized bridge joining the side pieces. The claspers are slender and sharp-pointed and have no setae on the ventral portion. The basistyli (ninth sternum) are strongly narrowed apically and are joined on the inner basal margins for a distance about equal to one-third their length; this juncture appears to be semi-membranous and a deep longitudinal furrow separates the basistyli (fig. 64d). The eighth sternum is convex, rather acutely pointed in the middle of the hind margin.

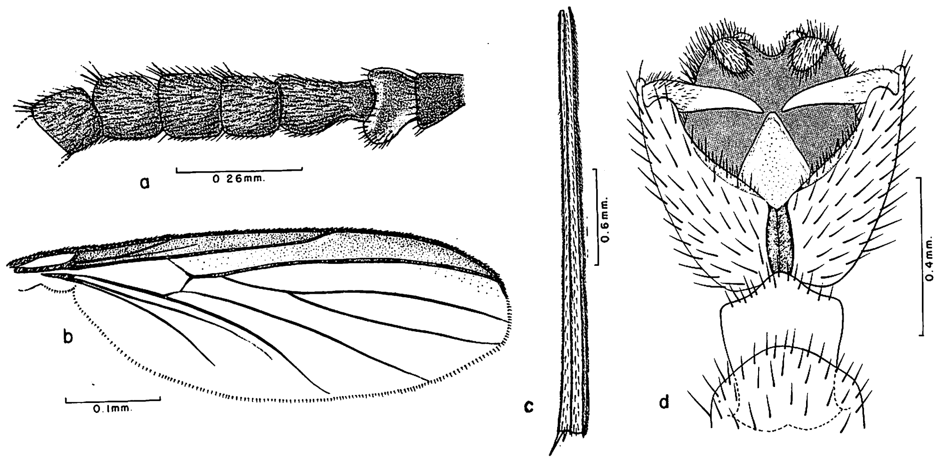

Figure 64—*Orfelia* (*Tylparua*) *cratericola* n.sp.: **a**, basal portion of antenna; **b**, wing; **c**, middle tibia; **d**, male genitalia, ventral view.

Length: body, 6.7–7.0 mm.; wings, 5.5–5.7 mm.

FEMALE. Fitting the description of the male in most details; the costal margin of the wing, however, is darker brown fumose and the remainder of the wing is

more intensely fumose. The antennae are about equal in length to the thorax, and the segments are not modified as in the male. Otherwise fitting the description of the male except for genital characters.

Length: body and wings, 6.7–7.0 mm.

Holotype male, allotype female, and two paratypes (1 male and 1 female): Paliku, Haleakala Crater, Maui, elev. 6,500 ft.; August, 1952 (W. C. Mitchell).

The type and allotype are being deposited in the U.S. National Museum. One paratype is in the B. P. Bishop Museum and one is in the University of Hawaii collection.

Orfelia (Tylparua) fuscocostata (Grimshaw) (figs. 65a–c).
Platyura fuscocostata Grimshaw, 1901, Fauna Hawaiiensis 3(1):2, pl. 1, figures 2–3.

Endemic. Hawaii (type locality: Kilauea), Maui, Molokai, and Kauai.

Type in the British Museum (Natural History).

This species appears to be rare. It has been poorly known and previously recorded from only a few female specimens. It is differentiated from other Hawaiian *Orfelia* by the brown fumose costal margin on the wing, by the presence of vein R_4, and by the second anal vein ending about opposite the m–cu crossvein. Its closest relative seems to be *O. cratericola* n. sp. The female specimens which have been seen are predominantly shining black. The species apparently is quite variable in coloration, or else two or more species may be represented in this concept; it has not been possible to obtain a large enough series of specimens to determine the importance of the various color differences.

The type female and a topotypic female have the thorax entirely shining black except for the yellow humeral ridges and yellow conjunctiva between the sclerites of the pleura. The hind coxae are black, the middle coxae are brown, the hind femora are yellow-brown, all of the tarsi are dark brown; the legs are otherwise mostly yellow. The abdomen is dark brown to black, the posterior margins of segments 2 to 6 are yellow. The antenna of the typical female has the two basal joints and the attenuated portion of the first flagellar segment yellow; the remainder of the antenna is dark brown and the segments are about as wide as long. The wing is as in figure 65b.

One female from North Slope, Hualalai, Hawaii, 4,000–6,000 ft., July, 1953 (D. E. Hardy), has a faint indication of rufous coloration on the front portion of the mesonotum and the mid and hind coxae are yellow. The pleural sclerites, excepting the metapleura, are brown. Female specimens from Nualolo Valley, Kauai, August 11, 1953 (D. E. Hardy); Puu Kukui, Maui, 4,500 ft., April, 1954 (M. Tamashiro); and Puu Kolekole, Molokai, July, 1952 (M. Tamashiro) have the abdomen completely black and all coxae and the middle and hind femora blackened.

Two male specimens from Puu Kolekole, Molokai, July, 1952 (M. Tamashiro) and Mokuleia, Kukuiala, Oahu, 1,500 ft., December 13, 1952 (C. Hoyt) and three from Napau Crater, Hawaii, 2,900 ft., July, 1956 (D. E. Hardy), seem to fit with the females in all structural details; but they differ strikingly in coloration. It was

first assumed that the males represented a new species but after careful comparisons it was decided that it would be best to place them under *fuscocostata*.

MALE. Head brown to black, face mostly yellow. Antennae about one-third longer than the head and thorax combined, colored as in the female; the flagellar segments, except for the attenuated first segment and those at apex, are distinctly broader than long (fig. 65a). The epistome is strongly produced and a well-developed mystax is present just above the oral margin (fig. 65a). The coloration of the thorax is rather similar to *O. hawaiiensis*. The mesonotum is largely yellow, with a broad band of black along sides and hind margin. The scutellum is black, except for a narrow band of yellow across its base. The metanotum is brown to black in the median portion, yellow on the sides. The pleura are yellow except for the dark brown to black metapleuron (pleurotergite) and except for a slight discoloration of brown on the lower portion of each sternopleuron (katepisternum of mesothorax) and on the upper edge of each hyplopleuron (metathoracic epimeron). The coxae, trochanters, and femora are almost entirely yellow. The costal margin of the wing is brown fumose, the remainder rather faintly infuscated. The subcostal vein enters the costa nearly opposite the base of the radial sector. The fused portion of M_{1+2} + Rs is about half as long as the free portion of M_{1+2}. The second anal vein ends about opposite the m–cu crossvein (fig. 65b). The abdomen is polished blue-black on the basal halves of the segments and yellow on the apices. The ninth tergum is about one-half longer than wide and has a shallow concavity on its posterior margin (fig. 65c); in *cratericola* the posterior margin has a more distinctly U-shaped concavity. In *fuscocostata* the eighth sternum is convex on its hind margin and terminates in a blunt point. The lateral lobes of the basistyli are sharp-pointed and extend approximately as far as the apex of the aedeagus. The dististyli (claspers) are slender and sharp-pointed and are devoid of bristles or hairs except on the dorsal portion near the base (fig. 65c).

Length: body, 6.0–7.0 mm.; wings, 4.5–5.0 mm.

Orfelia (Tylparua) hawaiiensis (Grimshaw) (figs. 62, 65d–g).

Platyura hawaiiensis Grimshaw, 1901, Fauna Hawaiiensis 3(1):3, pl. 1, figure 4.

Endemic. Hawaii (type series from Olaa, Kilauea, and Kona), Kauai, Molokai, Maui, and Lanai. (Rather common in wet areas in the mountains.)

Type in the British Museum (Natural History).

This species is differentiated from other Hawaiian *Orfelia* by the modification of the male antennae, the wing infuscation, the coloring of the thorax, and the male genitalia. The male antennae are about two times longer than the thorax and the flagellar segments are about two times longer than wide (fig. 65g). The anterior and median portions of the mesonotum and most of the pleura are yellow; the scutellum, metanotum, metapleura, and sides of mesonotum are usually shining black. The metanotum is completely bare. The subcostal vein enters the costa about opposite the base of the radial sector. The apical fourth to third of the wing is infuscated and the venation is as in figure 65d. The terga of the abdomen are shining black with yellow apices; the sterna are often all yellow. The genitalia

are yellow, tinged with brown. The ninth tergum is very broad, rather short, and evenly convex on hind margin (fig. 65e). The dististyli are short and sharp-pointed, each has two to four short erect setae on the ventral surface. The cerci are rather long and slender (fig. 65f).

Length: body and wings, 4.0–6.0 mm.

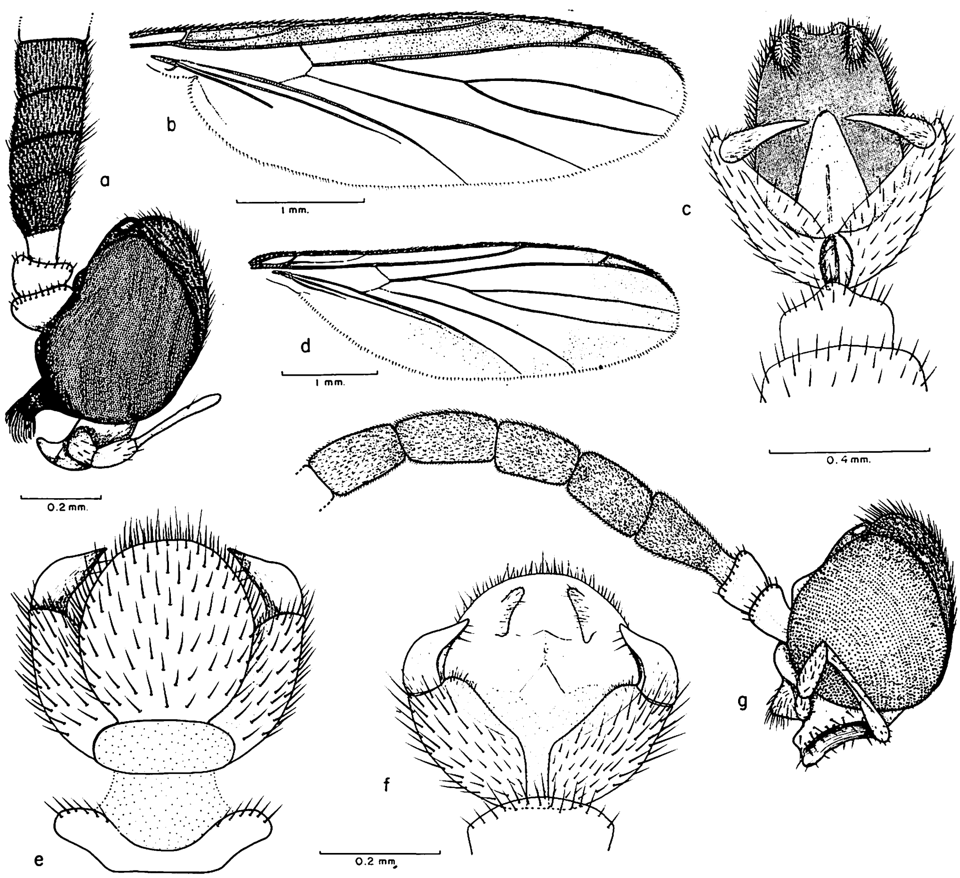

Figure 65—*Orfelia* (*Tylparua*) *fuscocostata* (Grimshaw): **a,** head, lateral view; **b,** wing; **c,** male genitalia, ventral view. *O.* (*Tylparua*) *hawaiiensis* (Grimshaw): **d,** wing; **e,** male genitalia, dorsal view; **f,** male genitalia, ventral view; **g,** head, lateral view.

Orfelia (Tylparua) insularis (Grimshaw) (figs. 66a–d).

Platyura insularis Grimshaw, 1901, Fauna Hawaiiensis 3(1):4, pl. 1, figure 5.

Endemic. Molokai, Hawaii, Lanai, Maui, Oahu, and Kauai (type series from "Molokai Mts., 3000 ft.," and "Kona, Hawaii, 4000 ft."). This is the most common of the Hawaiian mycetophilids. It has been taken at numerous localities in the mountains on all of the main islands.

Type in the British Museum (Natural History).

This is the smallest species of *Orfelia* in Hawaii. It is most closely related to *O. hawaiiensis* (Grimshaw) because of the rudimentary second anal vein and the development of the male genitalia. Typically, it is readily differentiated by the incomplete subcostal vein. A few specimens have been seen, however, which have a faint Sc extending to the wing margin. The best supplementary characters for distinguishing it are the shorter antennae and broader flagellar segments in the male (fig. 66a); the presence of several small setae on apical margin of the metanotum; the predominantly rufous, tinged with brown, mesonotum; and the more evenly infuscated wing. The subcostal vein usually ends abruptly about half way between the humeral crossvein and the base of Rs. Cell R_3 is narrowed and vein R_4 arises just slightly over half way between the tips of R_1 and R_5. The costa extends about half way between the tips of veins R_5 and M_1 (fig. 66b). Typically, the mesonotum is dirty yellow, paler on the sides and behind the humeri; individuals vary, however, from this condition to those which are almost entirely brown to black. The male genitalia are as in figures 66c and d. The ninth tergum is very broad, convex at apex, and densely setulose; it is nearly as wide as long. The basistyli are narrowly separated at base. The dististyli are short, and each is tapered to an acuminate point and has two ventral setae near apical third (fig. 66d). The cerci are rather long and slender.

Length: body and wings, 3.5 mm.–5.0 mm.

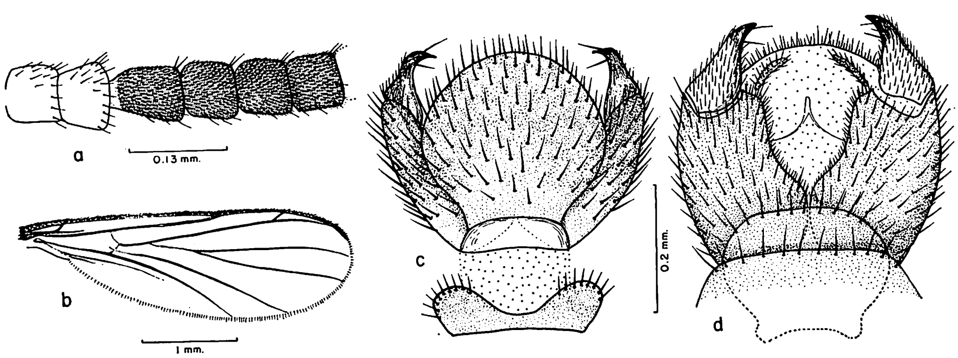

Figure 66—*Orfelia* (*Tylparua*) *insularis* (Grimshaw): **a,** basal portion of antenna; **b,** wing; **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view.

Family SCIARIDAE Billberg
Dark Winged Fungus Gnats

Sciaraedes Billberg, 1820, Enumeratio Insectorum in Museo Billberg. Stockholm, Gadel 4:121.

Sciarinae Zetterstedt, 1838, Insecta Lapponica, 3, Diptera, p.825.

Sciaridae Bigot, 1852, Ann. Soc. Ent. France (2)10:484.
Lycoriidae Speiser, 1910, in Sjostedt's, Wissensch. Ergebnisse der Schwedischen Zool. Exped. Kilimandjaro 2(10):31.

The family name is derived from the Greek skiaros, shady; evidently referring to the fumose wings of many of the species.

Small, chiefly dull-colored flies characterized by the wing venation; the midpleural pit; the large well-developed sternopleura (katepisterna of mesothorax), and by the development of a bridge of eye facets extending across the top of the head (fig. 68a). The subcosta and anal veins are short, poorly developed. The costa ends near the wing tip, the radius is unbranched, and media is three-branched with M_{3+4} arising from a common stem with Cu_1 as in many of the mycetophilids.

These flies have been treated as a subfamily of Mycetophilidae by many workers but, as Shaw has pointed out (1948:192; 1951:20), the group is sufficiently distinct from Mycetophilidae to be considered as a separate family. They are distinguished by the presence of midpleural pits, the greater development of the sternopleura, the shorter coxae, and by the lack of a meron at the base of the mesothoracic coxa. The sciarid wing venation is almost identical with that of the cecidomyiid subfamily Lestremiinae, compare figures 67a and 83b. The two groups may easily be confused—especially since the eye bridge is also developed in both—unless one checks for the continuous costa and the lack of tibial spurs on the Lestremiinae.

The number of rows of facets in the eye bridge is of value in distinguishing some Hawaiian species. From one to five rows are present, depending upon the genus and species. The eyes are pubescent and the antennae are 16-segmented in all of our species; the color of the segments is of some importance, but is variable and cannot be considered a reliable character. The shape of the flagellar segments is useful in separating some of the species. The maxillary palpi are typically three-segmented (fig. 70a); many workers consider the palpi to be four-segmented with a rudimentary first. Frey (1942:7) says they are three-segmented with the basal portion united with the galae. Two of our genera (*Plastosciara* Berg and *Spathobdella* Frey) have two-segmented palpi, and *Hyperlasion* Schmitz has but a single segment (fig. 79c). The presence or absence of a sensory structure on the first segment of the palpus is an important character in distinguishing Hawaiian species. Body color and color pattern of the mesonotum and pleura are useful characters but not entirely reliable, especially with slide preparations or teneral specimens. The wing venation is as shown in figure 69b. Comparison of the lengths of vein R_1 and crossvein r–m and the presence or absence of macrotrichia on the medial veins seem to be the only wing details of particular usefulness in separating our species. Just one species which has macrotrichia on the brances of media is known in the Islands. Lengersdorf (1930:24) uses this as a primary divisional character within the genus *Lycoria* (= *Sciara*). Frey (1942) uses it to set off a group of "genera." Edwards (1928a:17) uses it as a primary division of the species under the genus *Sciara*. I much prefer to treat our single species as a subgenus of *Sciara*. I have been unable to find any distinctive differences in the thoracic

chaetotaxy in any of our species. The male genital characters, especially the clasping structures, are very important in differentiating species. It is essential, however, that one have well-prepared microscope slide mounts for study. I believe it is obvious that many of the descriptions and figures of sciarid genitalia in the literature have been based upon insufficient material and poorly prepared mounts.

The larvae are elongate, slender, nearly white with heavily sclerotized black heads. The head is prognathous, subquadrate in shape, slightly tapered anteriorly. The front (median dorsal sclerite) is triangular, rather abruptly constricted on the posterior half of the head. The antennae are comparatively large and rounded, and a single ocellus is present just below each. The spiracles are brown to black and are present on the prothorax and the first seven abdominal segments. Those of the prothorax are several times larger than the latter, and each has five oblong openings in a row above the button-like spot (remnant of the previous tracheal opening).

The larvae most commonly develop in decaying plant and animal matter and in various types of fungi. They very often are abundant in potting soil in greenhouses and in potted plants. Outside of Hawaii, some sciarids are found breeding in tree sap, some are known to be leaf miners, and several are associated with ants and termites. The larvae of some species in the United States and Europe are gregarious and have the habit of migrating in a long rope-like line.

The larvae of some species may be of considerable economic importance. We have practically no information on their feeding habits in Hawaii. Elsewhere they have been recorded attacking the roots and underground portions of a wide range of plants, including mushrooms, lettuce, cucumbers, potatoes, wheat, corn, clover, alfalfa, apples, pineapples, carnations, pansies, tulips, as well as many ornamental plants grown in greenhouses and in pots. It is probable that most, if not all, of our species are primarily scavengers or fungivors, but, like some other flies with similar habits, they may on occasion attack living plant tissues. I suspect that plants with roots or other underground portions damaged by insects, disease, mechanically or by other factors, would be especially prone to attack by these flies. Illingworth (1934a) reported that under certain weather conditions the larvae of "*Sciara molokaiensis*" (very probably this was *S. garretti* Shaw; I have a number of records from pineapple fields) are very destructive to living roots of pineapple plants. He found the larvae devouring the ends of the new roots as fast as they pushed out and noted that rots would then set in and cause the death of the plant. The damage was done primarily to newly set plants. "By pulling up plants that have failed, it is not uncommon to find clusters of the worms congregated on the end of the cut surface." Illingworth said that these fiies undoubtedly do far more damage to pineapple than anyone suspected. They breed in very large numbers in the plant material which is decomposed and plowed under for fertilizer, and he felt that "they become a real menace to growing plants during periods of drought." He found that the soil moisture conditions appear directly to influence the feeding habits of the larvae. When the soil was moist and ample decaying organic matter was present, the larvae did not attack the

roots. When the moisture was reduced so that the feeding medium started to dry out, the larvae began feeding upon the roots; they turned to the living tissues as their only supply of moisture.

Illingworth also reported damage caused by sciarids attacking the roots of greenhouse plants. "Maidenhair fern were badly injured. Seedlings of some flowering plants are often almost a complete failure because of the ravages of these maggots." One species (*Plastosciara perniciosa* Edwards) is considered an important greenhouse pest in England and has also been reported as being destructive to the roots and stems of cucumbers in that country. We know nothing of the habits of the *Plastosciara* in Hawaii.

Sciaridae have apparently been the limiting factor in the few attempts which have been made to grow mushrooms commercially in Hawaii. A venture began again in 1953, using man-made caves which had been part of the defense system for Oahu. Within a few months after operations had begun, all of the growing boxes were infested with *Sciara garretti* Shaw (obviously brought in with the organic fertilizers), and the damage to the mushrooms soon became so severe that the business would have been greatly curtailed if control of the flies had not been effected. Control was accomplished by painting the flats with DDT, thus killing the adults as fast as they emerged.

The species of *Sciara* which we have observed in the laboratory locally (*molokaiensis* Grimshaw, *garretti* Shaw, and *hardyi* Shaw), require 24 to 30 days to complete their life cycle. This time varies somewhat depending upon weather (humidity) conditions.

The adults are often abundant at lights and are commonly seen on windows. In the field they inhabit moist places and are often found in association with mosses, lichen growths, rotting wood, and other decomposing vegetation and humus materials.

These flies have long been considered the "problem children" of the Diptera because of their reputation for being difficult (or impossible) to identify. Frey (1942:6) said that Professor Carl Lundström, the Finnish specialist on the Nematocera, wrote "Tufri fran detta!" (God preserve us!) on the title page of his copy of Winnertz's pioneer work *Beitrag zu einer Monographie der Sciariden.* The large majority of the species in the older literature have been based upon color characters, and even many of the recent descriptions place far too much emphasis on color and disregard some of the important structural details. The most recent revisional studies of the family are those of Frey (1942 and 1948). He has made outstanding contributions in putting the taxonomy of this group on a sound basis. His generic concepts seem a bit extreme, however, and for the Hawaiian species I prefer to follow Shaw (1952:491) in treating *Lycoriella* as a subgenus of *Sciara*. I also consider *Leptosciara* as a subgenus of *Sciara sens. lat.* Shaw (1953) has presented an excellent review of the sciarid literature and a translation into English of Frey's 1942 key to genera, arranged in dichotomous form. Dr. R. Tuomikoski, Helsinki, Finland, is now working on a generic revision of the family, and some of the concepts used in this book will have to be modified to fit his more up-to-date classification.

The Hawaiian sciarids have been almost completely neglected. Previous to Shaw's brief paper (1952), just one species (*Sciara molokaiensis* Grimshaw) had been treated in our literature. This had been based upon a single female and was completely unrecognizable from the original description. The collections in Hawaii and the references to these flies in our literature have been consistently misidentified. O. A. Johannsen reported two new species of "*Neosciara*" in material sent to him (Bryan, 1934:405), but he did not describe these.

Key to Genera and Subgenera of Sciaridae

1. Palpi with but 1 or 2 segments 2
   Palpi 3-segmented 5
2. Palpi 2-segmented (fig. 68b). Flagellar segments of antennae (except apical and basal) about one-half longer than wide . . . 3
   Palpi with but 1 segment, this with a large sensory structure at the apex (fig. 79c). Flagellar segments about two times longer than wide . . . . **Hyperlasion** Schmitz.
3. Second segment of palpus very tiny, not over one-fourth as long as first (fig. 67i). **Plastosciara** Berg 4
   Second segment of palpus slightly longer than first (fig. 80a) . . . . **Spathobdella** Frey.
4. Eye bridge broad, made up of 5 rows of facets (fig. 68a) . . . . **Plastosciara (Plastosciara)** Berg.
   Eye bridge narrow, 1–2 rows of facets in width . . . . **Plastosciara (Cosmosciara)** Frey.
5. Median veins setose, bearing distinct macrochaetae (fig. 69b). Thorax entirely rufous in the Hawaiian species . . . . **Sciara (Leptosciara)** Frey.
   Median veins bare 6
6. Middle and hind tibiae each with 2 strong apical spurs . . . . **Sciara (Lycoriella)** Frey.
   Middle and hind tibiae with but a single spur. Vein R_1 very short, about equal to r–m crossvein. Third segment of palpus very short, about equal in length to the second . . . . **Scatopsciara** Edwards.

Genus **PLASTOSCIARA** Berg

Pseudosciara Kieffer, 1898, Bull. Ent. Soc. France 1898:194; *nec Pseudosciara* Schiner, 1866, Verh. Zool.-bot. Ges. Wien 16:930.

Plastosciara Berg, 1899, Comun. Mus. Nac. Buenos Aires 1(3):78.

The members of this genus are characterized by two segments in the palpi with the second very small, rather short flagellar segments of the antennae, sparsely haired eyes, lack of macrotrichia on the median veins, and by having the spurs of the hind tibiae about equal in length and usually about equal or but little longer than the diameter of the tibia. Another detail which seems of importance

in separating *Plastosciara* is the presence of just two strong bristles on the margin of the scutellum and the sparse, or completely absent, acrostichal hairs.

Subgenus **COSMOSCIARA** Frey, 1942

Cosmosciara Frey, 1942, Not. Ent. 22:39.
Plastosciara (*Cosmosciara*) Frey, 1948, Not. Ent. 27:71, 88.

Dr. R. Tuomikoski, Helsinki, Finland, has informed me in correspondence that *Termitosciara* Schmitz (1915, Tijds. Ent. 58:281) may be an older name for this group.

The group has been characterized by Frey as very small individuals, with narrow eye bridge, composed of two or three rows of facets, bare r–m crossvein, and with the female abdomen not elongated and the male claspers differently developed than in *Plastosciara sens. str.*

I am not certain that the presence or absence of setae on the r–m crossvein is of any subgeneric value. This seems quite variable in the material studied and most of our species have some setae over the entire crossvein. Our species seem to fit Frey's concept of *Cosmosciara* except for the variation in the setae on r–m and except that some have longer tibial spurs than he indicates is typical. This appears to be an excellent specific character but, at least in this case, does not seem of any generic or subgeneric value.

Three Hawaiian species fit in this subgenus.

Type of subgenus: *Plastosciara perniciosa* Edwards.

Key to Species of Plastosciara (Cosmosciara)

1. Spurs of hind tibia at least one-third to one-half longer than diameter of segment. Male clasper not more than two times longer than wide. Ninth tergum of male quadrate or nearly so, covered with bristles (fig. 67j). Crossvein r–m about equal in length to base of M (fig. 67h) 2

   Spurs of hind tibia very short, slightly less than diameter of tibia. Claspers more slender, two and a half times longer than wide (fig. 67g). Ninth tergum two times wider than long, bristled only on posterior portion (fig. 67f). Crossvein r–m about half as long as M (fig. 67d) .... **brevicalcarata** Hardy.

2. Costa extending two-thirds the distance to M_1. Crossvein r–m bare. Apices of ninth sternum produced into distinct lobes, extending over bases of claspers. Claspers short and broad, scarcely a third longer than wide and with a clump of four short, thick spines at apex (fig. 67c) .... **adrostylata** Hardy.

   Costa extending four-fifths the distance to M_1. Crossvein r–m setose. Hind margins of ninth sternum not distinctly lobate. Claspers two times longer than wide, blunt at

apices, and with two moderately strong subapical spines (fig. 67j) .... **longicosta** Hardy.

Plastosciara (Cosmosciara) adrostylata Hardy (figs. 67a–c).

Plastosciara (Cosmosciara) adrostylata Hardy, 1956, Proc. Haw. Ent. Soc. 16:72.

Endemic. Oahu (type locality: Waikane), Hawaii, and probably on other islands. Probably living in rotting wood. It has been collected "ex dead *Xanthoxylum.*" A male specimen from Keaau Orchard, Olaa, Hawaii, light trap collection, August, 1956, appears to be this species.

Type in the B. P. Bishop Museum.

This species, as well as *P. longicosta* Hardy, would not fit Frey's concept of *Plastosciara* (Frey, 1948:46) because of the more elongate spurs on the hind tibiae. In Frey's key it runs imperfectly to *Spathobdella* Frey; but in that genus the second segment of the palpus is elongated. Both species differ from *P. flavibasis* Edwards, from Samoa, by having the eye bridge narrowed to a single row of facets and then discontinuous on the top of the head for a distance equal to the length of two or three facets, not "three facets wide." Also the thorax is brown, not "shining black"; the tibial spurs are longer than the diameter of the tibia, not "fully as long as . . ."; the abdominal sclerites are brown, not with the first tergum yellow and two to four black; the claspers of the male have several spines at apex, not "with two bristly spines at tip"; and the wings measure 1.4 to 1.5 mm., not 2.0 mm. *P. adrostylata* and *longicosta* are separated by the wing venation and by the characters of the male genitalia as pointed out in the above key and as shown in figures 67b and 67j. For more complete details refer to the original description.

Length: body, 1.5–1.7 mm.; wings, 1.4–1.5 mm.

Plastosciara (Cosmosciara) brevicalcarata Hardy (figs. 67d–g).

Plastosciara (Cosmosciara) brevicalcarata Hardy, 1956, Proc. Haw. Ent. Soc. 16:73.

Endemic. Oahu (type locality: Honolulu). Rather common on windows and at light.

Type in the B. P. Bishop Museum.

This species is distinguished from other known *Cosmosciara* by the very short tibial spurs and by the short broad ninth tergum of the male (fig. 67f). The male claspers are more slender and the ninth tergum much broader than in any other known Hawaiian species; the tergum also has setae only along the posterior margin (fig. 67f). The wing venation also differs from that of other Hawaiian species as shown in figure 67d. For the details of the palpus refer to figure 67e, and for further descriptive information refer to original description.

Length: body, 1.3 mm.; wings, 1.1 mm.

Plastosciara (Cosmosciara) longicosta Hardy (figs. 67h–j).

Plastosciara (Cosmosciara) longicosta Hardy, 1956, Proc. Haw. Ent. Soc. 16:75.

Endemic. Oahu (type locality: Halawa Ridge), Kauai, and Maui. Reared from rotting wood and taken on windows and at light.

Type in the B. P. Bishop Museum.

Fitting close to *P. adrostylata* Hardy, but differing by having the male clasper two times longer than wide and the apical spines stronger and not densely clumped; the ninth sternum is not as distinctly lobate on the hind margin, and the other structures of the genitalia are differently developed (fig. 67j). Also the costa extends about four-fifths the distance between the tips of R_{4+5} and M_1 rather than two-thirds the distance; the r–m crossvein is setose over most of its length rather than bare, and the flagellar segments of the antennae are longer than wide. See figures 67h, i, and j, and refer to original description for further details.

Length: body, 1.5 mm.; wings, 1.35 mm.

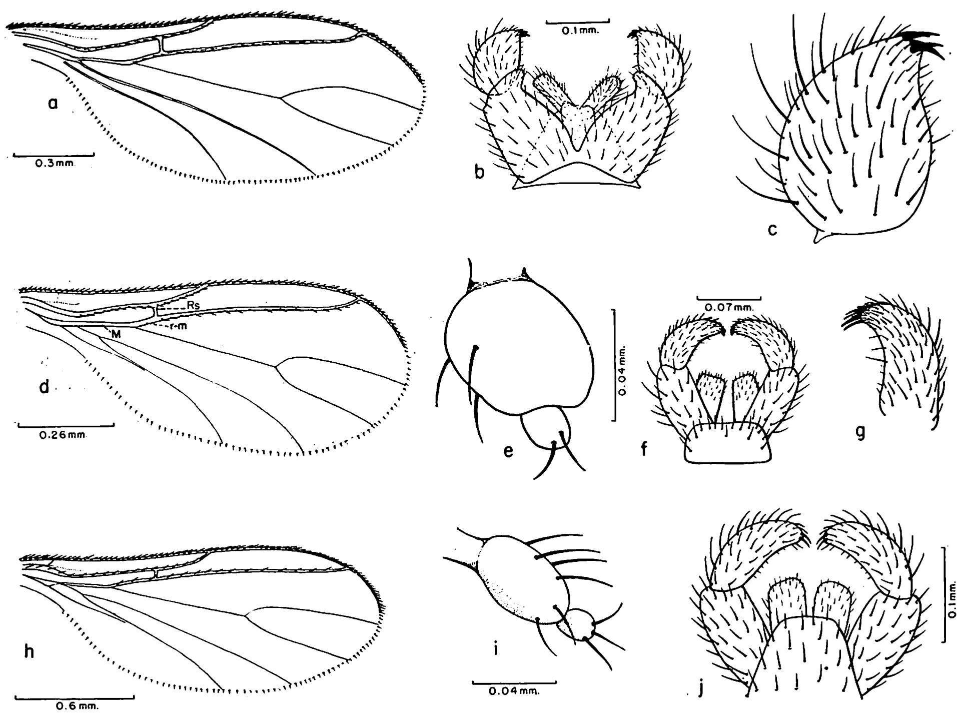

Figure 67—*Plastosciara* (*Cosmosciara*) *adrostylata* Hardy: **a,** wing; **b,** male genitalia, ventra, view; **c,** male clasper. *P.* (*Cosmosciara*) *brevicalcarata* Hardy: **d,** wing; **e,** palpus; **f,** male genitalia Dorsal view; **g,** male clasper. *P.* (*Cosmosciara*) *longicosta* Hardy: **h,** wing; **i,** palpus; **j,** male genitalia, dorsal view.

Plastosciara (Cosmosciara) perniciosa Edwards.

Plastosciara perniciosa Edwards, 1922, Ent. Month. Mag., 3rd ser. 8:160.

This species apparently does not occur in Hawaii, but I am giving comparative notes on it since Edwards has recorded it from Samoa and the Marquesas and I feel that there is a possibility he may have been dealing with one of the species which occurs here in Hawaii. There obviously has been some confusion regarding the recognition of this species and I feel that Edwards, and others, may have been dealing with a complex of related species. The original description

gives the following pertinent details: Eyes bare, eye bridge narrow (I presume Edwards meant that the bridge narrows to one or two rows of facets), "forming a distinct though narrow dorsal bridge, the portions from each eye being narrowed almost to a point, the points touching"; antennae black, flagellar segments a little over one-half longer than wide; first segment of palps nearly globular, the second minute; thorax dark brown to black; scutellum with two bristles; legs dark brownish, tibial spurs very short, considerably shorter than the diameter of the tibiae; hind basitarsi proportions to tibiae, 22:48; wings slightly grayish tinged; costa extending three-fourths to apex of M_1; crossvein r–m a little longer than the vertical portion of Rs; R_1 ending in the costa far before the base of cell M_1; median fork shorter than its stem; stem of M_{3+4} and Cu_1 very short; anal vein approximates Cu and actually seems to unite with it so at first sight they appear as one vein; abdomen dark brown, conjunctiva whitish; male claspers a little over twice as long as wide, with a single subterminal spine mixed with some hairs.

Length: wing, 1.2–1.5 mm.; body, male, 1.0–1.3; female, 1.5–1.8 mm.

Type in the British Museum (Natural History).

I have studied three female specimens (from England), determined by Edwards as *P. perniciosa*. These have three rows of facets in the eye bridge; the spurs of the hind tibiae are one-half longer than the diameter of the tibia; the r–m crossvein is several times longer than the vertical portion of Rs (I feel Edwards may have made an error on this character), and vein R_1 ends at a point opposite the apical two-thirds of M_{1+2}. These specimens very probably represent a distinct species from Edwards' type of *perniciosa*.

The genitalia as figured by Frey (1948, fig. 130) are probably correct for *perniciosa*. Lengersdorf's figure of this species (1930, fig. 10) is obviously based upon a specimen in poor condition; the claspers appear to be shrunken. *P. perniciosa* apparently is closest to *P. brevicalcarata* Hardy (of the Hawaiian species) but is distinguished by the single strong spine at apex of each clasper, probably also by wing venation and other details.

P. perniciosa is said to be a common greenhouse pest in England. The larvae are reputedly destructive, especially to cucumbers grown under glass.

Subgenus **PLASTOSCIARA** Berg

Plastosciara (*Plastosciara*) Berg, Frey, 1948, Not. Ent. 27:70.

This subgenus is characterized by Frey (1948:70) as including medium-sized species with distinctly setose r–m crossvein ("Y" of Frey); broad eye bridge made up of 4–6 (rarely 3) rows of facets; short tibial spurs; dark halteres; black-haired abdomen; attenuated female abdomen with the last segment very long and drawn out and with an elongate ovipositor; and with short and thick male claspers armed with several stout spines on the inner surface below the apex.

I have seen but one Hawaiian species which would fit here because of its very broad eye bridge. It does not entirely fit Frey's concepts, however, since the r–m

is not setose except for two to three scattered hairs and the male claspers are rather slender and armed with two to three short subapical spines (fig. 68d). The females of this species have not been studied, so it is not known whether or not they will fit Frey's concept.

Type of subgenus: *Plastosciara lignicola* (Winnertz).

Plastosciara (Plastosciara) latipons Hardy (figs. 68a–d).

Plastosciara (*Plastosciara*) *latipons* Hardy, 1956, Proc. Haw. Ent. Soc. 16:77.

Endemic. Oahu (type locality: Ewa). Known only from light-trap collections at Ewa.

Type (no. 2484) in the B. P. Bishop Museum, Honolulu.

This species differs from all known *Plastosciara* (*Plastosciara*) by having the male claspers three times longer than wide and with no strong spines on inner margin (fig. 68d).

The eye bridge is made up of five rows of facets and occupies the entire area between the antennae and the lower ocellus (fig. 68a). The palpus is as in figure 68b; the second segment is less than one-fifth as long as the first and has three setae at its apex. The thorax and abdomen are predominantly brown and the legs chiefly yellow. The genitalia are as in figures 68c and 68d. For further details see the original description.

Length: body, 1.6 mm.; wings, 1.4 mm.

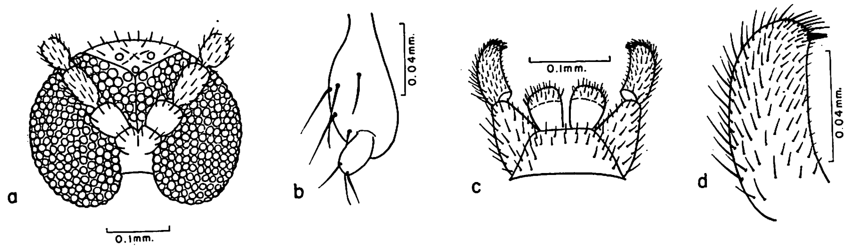

Figure 68—*Plastosciara* (*Plastosciara*) *latipons* Hardy: **a,** head, front view; **b,** palpus; **c,** male genitalia, dorsal view; **d,** male clasper.

Genus **SCIARA** Meigen

Lycoria Meigen, 1800, N. Class. Mouches, 17. Rejected name.

Sciara Meigen, 1803, Mag. f. Insektenk. 2:263.

I am using this name in a broad sense to include those Hawaiian sciarids which have three-segmented palpi, the flagellar segments of the antennae approximately two times longer than wide, the middle and hind tibiae each with two spurs, and the legs more elongate with more slender segments, the tibiae being distinctly longer than the femora.

Type of genus: *Tipula thomae* Linnaeus.

No species of typical *Sciara* are known from Hawaii.

Subgenus **LEPTOSCIARA** Frey, **new status**

Leptosciara Frey, 1942, Not. Ent. 22:28.

This group is separated from *Sciara sens. lat.* by having macrotrichia on the medial veins (fig. 69b). I find no supporting characters except that the last palpal segment is very elongate and slender in the species at hand, but this is probably a specific character since some of the European species which Frey places in *Leptosciara* have the third segment short. *Sciara* (*Leptosciara*) is very close to *Sciara* (*Sciara*). Frey separates it by the setose r–m crossvein, the slender body, and the strong dorsocentral bristles in contrast to lacking setae on the r–m, having the body stout, and the dorsocentrals hair-like.

Just a single species appears to be present in Hawaii. To my knowledge it is the only *Leptosciara* which has been reported from the Pacific. It is probable, however, that a number of the species in the literature under *Sciara* should belong here. It certainly appears that *Sciara distigma* Edwards, from Fiji, fits in this subgenus: or it may possibly be a *Sciara* (*Sciara*).

Type of subgenus: *Sciara longiventris* Zetterstedt.

Sciara (Leptosciara) hawaiiensis Hardy (figs. 69a–d).
Sciara (*Leptosciara*) *hawaiiensis* Hardy, 1956, Proc. Haw. Ent. Soc. 16:78.

Endemic. Oahu (type locality: Mt. Tantalus), Maui, Kauai, Molokai, Hawaii, and Lanai. This is a rather common species in the mountains from 1,500 to 5,000 feet in elevation, and it has been reared from rotting wood and from *Freycinetia* plants ("Ieie") on several occasions. It is found at lower elevations (in light-trap collections), but in fewer numbers than in the mountains.

Type in the B. P. Bishop Museum.

I have been unable to ally this to any species known to me. It seems to fit closer to *Sciara distigma* Edwards, from Fiji, than to any other *Sciara* known to me. The Fijian species differs, however, by having the mesonotum shining orange colored, with a pair of black, widely separated oval spots at about the middle, and by having the hairs on the thorax small and inconspicuous (this may be a *Sciara sens. str.*). In Edwards' key to the Oriental species (1928a:20), it runs to *Phorodonta pubericornis* Edwards; but the claws are simple, not toothed, the male antennal segments are not covered with long pubescence, and the constrictions between the segments are not unusually long. *Sciara dives* Johannsen and *S. vicina* Johannsen, both from New York, may possibly be *Leptosciara*, but they are black species with very differently developed genitalia.

S. hawaiiensis is easily differentiated from all other known Hawaiian sciarids by the setose median veins, the elongate third palpal segment, the entirely rufous thorax, and by the genital characters. For details of the palpi, wings, and genitalia see figures 69a, b, and c, and for further descriptive information refer to original.

Length: body and wings, 1.8–2.2 mm.

Dr. R. Tuomikoski, Helsinki, Finland, has informed me that this species apparently belongs to an undescribed genus which he has in manuscript. He in-

dicated that the diagnostic characters are as follows: (1) apex of front tibia with a comb-like row of setae traversing a bare area on the anterior side; (2) clasper with one of the most apical spines stronger than the others; and (3) posterior pronotum without macrotrichia. *S. hawaiiensis* fits these characters: the front tibia is as in figure 69d, the apical spine on the clasper is stronger than the rest, and the pronotum is bare.

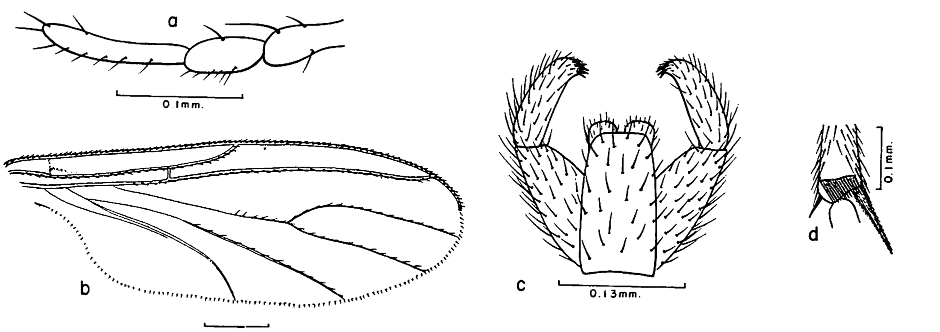

Figure 69—*Sciara* (*Leptosciara*) *hawaiiensis* Hardy: **a,** male palpus; **b,** wing; **c,** male genitalia, dorsal view; **d,** apex of front tibia.

Subgenus **LYCORIELLA** Frey

Lycoriella Frey, 1942, Not. Ent. 22:22.

Most of the species of Hawaiian sciarids fall into Frey's *Lycoriella* because the median veins and the r–m crossvein are devoid of macrotrichia; the rostrum is not elongated; vein M_1 is not strongly arcuate; the eyes are haired; the spurs of the middle and hind tarsi are about equal in length, and the third segment of the palpus is longer than the second.

My concept of *Lycoriella* is probably much too broad and will have to be modified when Dr. Tuomikoski publishes his generic revision of the sciarids. He has informed me, in correspondence, that of the species which I have treated under *Lycoriella*, only *Sciara* (*Lycoriella*) *solispina* Hardy clearly belongs to the subgenus *Lycoriella sens. str.* of his manuscript. This is a well-defined group characterized by the peculiar sensory structure consisting of a deeply excavated hollow with a rather narrow opening on the first segment of the palpus; by the anterior apex of the front tibia lacking a comb of setae but having a rounded patch of dense hairs separated from the usual hair coating by a narrow hairless area (fig. 76e); and by the presence of a small tuft of setae on the median ventral line of the ninth sternum of the male (fig. 76d). Also, the dististyli are rather long, each with a stout apical spine and with the inner side not conspicuously excavated longitudinally. The other species which I have tentatively treated under *Lycoriella* lack the above characters; the front tibia has a small comb of hairs on the anteroventral apex (fig. 71c), and the palpi and genitalia are quite different. Tuomi-

koski says these species "belong to other subgenera than *solispina*."... "Taken in such a narrow sense, *Lycoriella s. str.* (subgenus) will include species like *auripila* Winn., *sensu* Frey, *mycorum* Frey, *paucisetulosa* Frey, *stramentosum* Frey, *fucorum* Frey, *lundstroemi* Frey, *pauciseta* Felt, *agraria* Felt, *nitidicollis* Meig., sensu Edw. 1925, *solispina* Hardy."

Type of subgenus: *Bradysia* (*Chaetosciara*) *paucisetulosa* Frey (Frey, 1948:63). This was previously (Frey, 1942:22) misidentified as *Sciara vivida* Winnertz. The type specimen has been checked by Tuomikoski and found to possess the essential characters of his concept of *Lycoriella sens. str.*

Key to Species of Sciara (Lycoriella) sens. lat.

1. Mesonotum rufous, usually with a few streaks of brown....2
   Mesonotum entirely dark-colored.......................4

2(1). First palpus without a sensory structure (fig. 77a). Claspers of male without strong bristles on inner median surface....................................3
   First palpus with a large sensory structure (fig. 70a). Claspers with two large spines near middle (fig. 70f). Each pleuron with a conspicuous yellow stripe extending longitudinally through the middle (fig. 70d)...... ....**garretti** Shaw.

3(2). Ninth tergum of male very large, swollen, extending nearly to apices of ninth tergum (basistyli) (fig. 77c). Sternopleura entirely yellow to rufous.............. ....**spatitergum** Hardy.
   Tergum small, not conspicuously developed. Lower portions of sternopleura brown..........**radicum** Brunetti.

4(1). Claspers each containing three or more strong spines at or near apex......................................5
   Just a single spine at apex of clasper (fig. 76c)........ ....**solispina** Hardy.

5(4). Male claspers with three strong spines below (near apical two-thirds) besides the group of apical spines (fig. 72c). Costa ending just beyond middle of distance between tips of R_{4+5} and M_1 (fig. 72b).....**hoyti** Hardy.
   Claspers with not more than one strong spine below besides apical or subapical set. Costa extending about three-fourths to M_1...............................6

6(5). Male claspers very broad, not two times longer than wide, equal in width to slightly wider than the apices of basistyli. Claspers shaped as in figure 73b with a distinct concavity on upper, inner surface............... ....**latistylata** Hardy.

Claspers narrower, about three times longer than wide, distinctly narrower than basistyli, and very different in shape and development from the above..............7

7(6). Claspers with a very strong spine situated on a prominence below the inner median surface (fig. 75b)...... ....**prominens** Hardy.

Without such a spine on the inner median surface..........8

8(7). Antennae entirely dark-colored. First palpus with a sensory structure (fig. 71a). Male clasper with one strong apical and four subapical spines (fig. 71e)..**hardyi** Shaw.

Scape, pedicel, and sometimes basal half of first flagellar segments usually yellow. Palpus without a sensory structure (fig. 74a). No strong apical spines on clasper (fig. 74b)....................**molokaiensis** Grimshaw.

Sciara (Lycoriella) garretti Shaw (figs. 70a–g).

Sciara (Lycoriella) garretti Shaw, 1952, Proc. Haw. Ent. Soc. 14:494.

Sciara (Lycoriella) johannseni Shaw, 1952, Proc. Haw. Ent. Soc. 14:493, Figure 1., *nec johannseni* Enderlein, 1912. Zool. Anz. 40:282. **New synonym.**

Sciara (Lycoriella) laffooni Shaw, 1952, Proc. Haw. Ent. Soc. 14:494. **New synonym.**

Endemic? Oahu (type locality: "Island of Oahu"), Maui, Kauai, Hawaii, Laysan, and Midway (probably occurs on all of the main islands and on most of the smaller islands of the Hawaiian chain). This species is very common in the lowlands. A series of females, which seem to fit here, are in the B. P. Bishop Museum collection from Ocean Island (Gilbert Islands), April, 1923 (D. T. Fullaway). It is probable that this is an immigrant to Hawaii.

Type in the Shaw collection; to be deposited in the U. S. National Museum.

I have studied the type series. The species was described from two males which supposedly differed from *johannseni* Shaw by having the entire antenna dark brown. The antenna of the type is actually identical with that of the type of *johannseni*, the basal segments are yellow and the flagellar segments brown, lightly tinged with yellow; the paratype has the scape slightly discolored with brown. It is not unusual to have the basal antennal segments tinged with brown on this species. The genitalia and other details are identical with *johannseni*. Shaw's differences in the "structure of the hypopygium" are based upon the poor preparations which he had for study. It appears that all of these were mounted without clearing or relaxing, or they were dehydrated too abruptly causing shrinkage and contortion of the structures.

S. johannseni Shaw was based upon one male, whose head is glued on a paper point, and on one wing and the abdomen which are mounted on a slide (the remainder of the body is missing). The abdomen is poorly mounted and the genitalia are slightly twisted, accounting for Shaw's misinterpretation as shown in

his figure 1. A pin containing two females is marked paratype (the original indicated one paratype male); one of these had the tip of the abdomen glued under, and, upon superficial examination, could have been mistaken for a male. I have mounted this specimen.

Shaw based his *johannseni* upon coloration differences in the antennae (flagellar segments ochreous rather than dark brown) and upon the differences which he saw in the male claspers. I find the flagellar segments of the type brown with a faint yellowish tinge. This character is of no value—I have seen variations from black to all yellow, depending upon tenerality of the specimen, upon bleaching due to age, or on exposure to heat (in light traps). Shaw's figure is of a clasper which is twisted so that it is seen nearly in ventral view rather than lateral; he failed to indicate the apical and subapical bristles which are present. The male specimen from Honolulu, which Shaw indicated as an "atypical variety of *Sciara johannseni*," is in fairly good condition and is much more typical of the species than is the specimen which Shaw designated as the type.

S. laffooni Shaw was "described from two males from light trap... in Honolulu." I have studied the type and the paratype and find these are both specimens of *S. garretti* (and *johannseni* Shaw). They are mounted on paper points, but the diagnostic characters were obvious and I have made a slide mount of the paratype. Another male specimen was in the collection returned from Shaw; it consists of one wing and the abdomen mounted on a slide. This was not designated as a paratype but is obviously the specimen figured (fig. 4) by Shaw as *laffooni*. This is a good species, but the name *laffooni* is not available for it since the type is a synonym.

This species resembles *S. radicum* Brunetti very closely except that *radicum* has no sensory structure on the palpus and the genitalia are very different (fig. 75c). In coloration, except for the dark colored lower portion of the sternopleura, it is much like *S. spatitergum* Hardy. The genitalia and palpi are very different, as discussed under that species and as shown in figures.

S. garretti can be readily differentiated from other Hawaiian sciarids by the presence of a large sensory pit on the first segment of the palpus (fig. 70a); by the two large spines on the inner median surface of each clasper (dististylus) (figs. 70e–f) (in a large series of specimens some individuals will vary slightly from the typical form); and by the predominantly rufous mesonotum and the distinct yellow stripe which extends longitudinally from front to hind margin of each pleuron at a level with the upper two-fifths of the sternopleuron (fig. 70d). The mesonotum usually has two or three narrow brown vittae extending over the front portion in a W-shaped pattern (fig. 70c). The sides of the mesonotum are narrowly brown and the hind portion is often discolored with brown before the scutellum. The scutellum is brown, tinged with rufous. The pleura are largely brown, the brown colored lower three-fifths of each sternopleuron sets off the yellow longitudinal stripe. The basal segments of the antennae are normally yellow (fig. 70a) and the first flagellar segment is often partially yellow. The tip of the female abdomen is as in figure 70g.

Length: body, 1.25–1.75 mm.; wings, 1.6–2.0 mm.

This species has been reared from decaying sugarcane, pineapple, and other plants. It is common in the pineapple fields when the mulch is rotting and is probably the species which Illingworth (1934) reported as causing damage to pineapple plants. An infestation of *S. garretti* caused very severe damage to mushrooms in a commercial planting at Kaneohe, Oahu, until controlled by painting the sides of the planting boxes with a DDT solution.

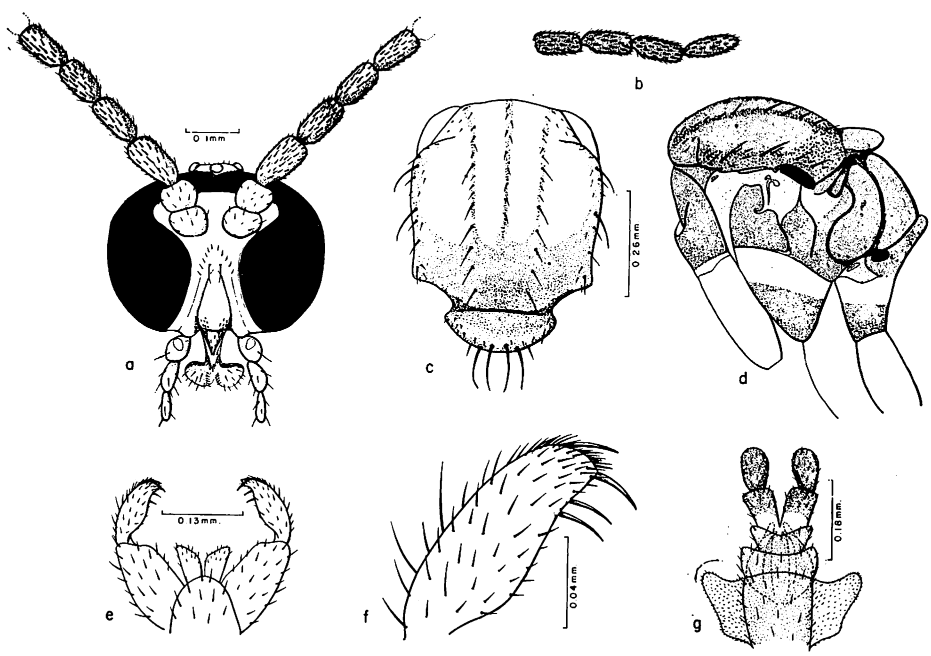

Figure 70—*Sciara* (*Lycoriella*) *garretti* Shaw: **a,** head, front view; **b,** apex of antenna; **c,** mesonotum, dorsal view; **d,** thorax, lateral view; **e,** male genitalia, dorsal view; **f,** male clasper; **g,** female genitalia, dorsal view.

Sciara (Lycoriella) hardyi Shaw (figs. 71a–e).

Sciara (*Lycoriella*) *hardyi* Shaw, 1952, Proc. Haw. Ent. Soc. 14:493.

Endemic? Oahu (type locality: Honolulu), Maui, Molokai, Kauai, and Hawaii (probably on all of the main islands).

Type in Shaw collection; to be deposited in U.S. National Museum.

I have studied the type male. This is a common lowland species and breeds in decaying vegetation. Shaw separated this species by its all dark-colored antennae and black mesonotum. The antennal coloration is not reliable, and some specimens are easily confused with *S. molokaiensis* Grimshaw because the basal segments are often yellow, just slightly tinged with brown. The important characters for separating it are: the presence of a moderately small sensory struc-

ture on the first segment of each palp (fig. 71a), subshining black mesonotum, brown to black pleura, and the claspers (dististyli) with a strong apical spine and four subapical spines (fig. 71e). Three prominent bristles are present on the outside median surface of the dististylus. The third segment of the palpus is nearly two times longer than the second. For other details see figures 71b–d.

Length: body, 1.2–1.55 mm.; wings, 1.5–1.7 mm.

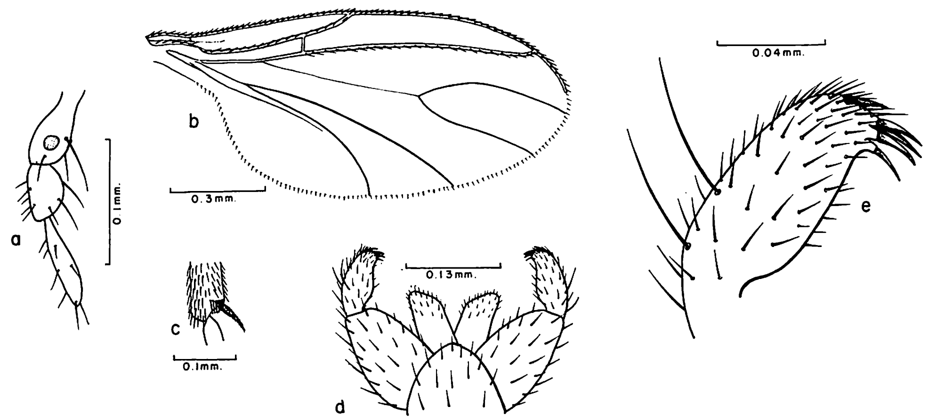

Figure 71—*Sciara* (*Lycoriella*) *hardyi* Shaw: **a,** palpus; **b,** wing; **c,** apex of front tibia; **d,** male genitalia, dorsal view; **e,** male clasper.

Sciara (Lycoriella) hoyti Hardy (figs. 72a–c).

Sciara (*Lycoriella*) *hoyti* Hardy, 1946, Proc. Haw. Ent. Soc. 16:80.

Endemic. Hawaii (type locality: Keanakolu, north slopes of Mauna Kea, 5,200 ft.). Reared from moss.

Type in the B. P. Bishop Museum.

An almost entirely dark brown to black species resembling *S. hardyi* Shaw, but the palpi are short and the sensory structure on the first segment is rather large, as in figure 72a, and the male genitalia are very different, as in figure 72c. The females are difficult to separate from those of *S. prominens* Hardy. The most reliable characters for separating them seems to be the presence of a dense clump of sensory setae on the first segment of the palpus and the short costa and subcosta in *hoyti*; the costa extends just slightly beyond the middle of the distance between the tips of veins R_{4+5} and M_1, and subcosta ends about opposite the forking of M_{3+4} and Cu_1, well before the base of r–m crossvein (fig. 72b). In *prominens* the costa extends about four-fifths the distance to M_1, and the subcosta is rather well developed and extends to the middle of the r–m crossvein. Also, in *hoyti*, the wings are less dusky and vein R_1 is shorter (about equal or slightly longer than r–m crossvein) rather than one-half longer, as in *prominens*.

The antennae are entirely brown. The palpi are as in figure 72a and the wings

and genitalia are as in figures 72b and c. The claspers are broad, about two times longer than wide, with three closely grouped spines at apex and three moderately strong, distinctly spaced spines on underside at about apical two-thirds.

Length: body, 1.7–2.0 mm.; wings, 1.5 mm.

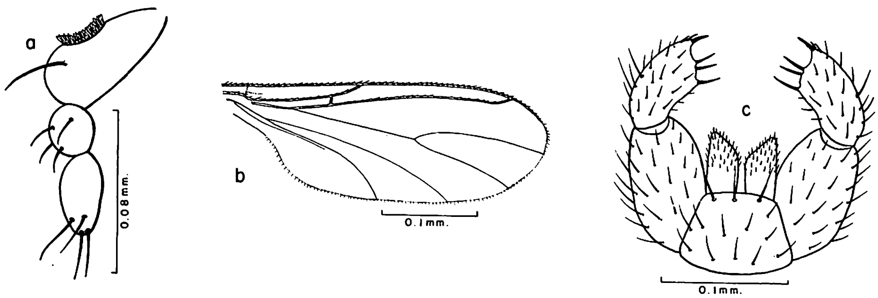

Figure 72—*Sciara* (*Lycoriella*) *hoyti* Hardy: **a,** palpus; **b,** wing; **c,** male genitalia, dorsal view.

Sciara (Lycoriella) latistylata Hardy (figs. 73a–e).

Sciara (*Lycoriella*) *latistylata* Hardy, 1956, Proc. Haw. Ent. Soc. 16:82.

Endemic. Oahu (type locality: Kuliouou, 1,500 ft.).

Type in the B. P. Bishop Museum.

A predominantly dark-colored species resembling *S. hardyi* Shaw until the male genitalia are studied. It is readily distinguished from all other known Hawaiian sciarids by the distinctive shape of the male clasping structures (fig. 73a). The claspers are very broad, equal in width or slightly wider than the apices of the lobes of the sternum (basistyli). The inner surfaces are markedly concave

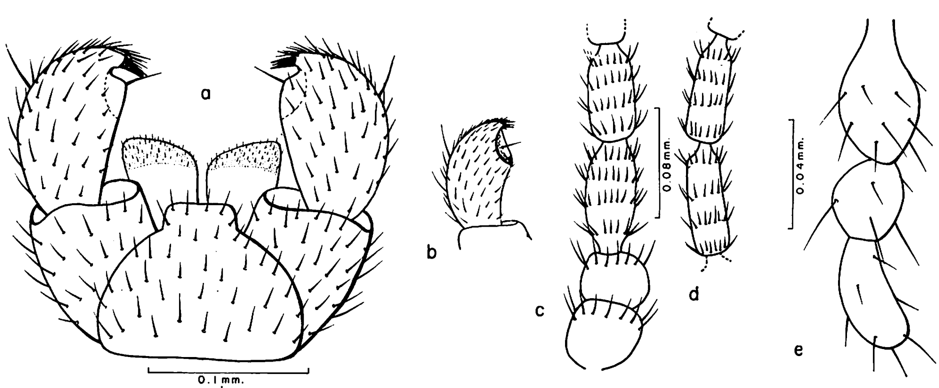

Figure 73—*Sciara* (*Lycoriella*) *latistylata* Hardy: **a,** male genitalia, dorsal view; **b,** inner view of male clasper; **c,** basal portion of antenna; **d,** middle flagellar segments; **e,** palpus.

on the upper half and have one strong spine arising from near the ventral edge of the concavity at the apical two-thirds of the clasper; there are also four or five rather well-developed subapical spines present (fig. 73b). The claspers are about equal in length to the sternum (fig. 73a). The antennae are entirely dark brown, the flagellar segments are about three times longer than wide (not including constriction between nodes) and each has four distinct whorls of setae (figs. 73c–d). Eye bridge made up of three or four rows of facets. Palpi with no sensory structure on the first segment (fig. 73e). For other details refer to the original description.

Length: body, 1.7–1.8 mm.; wings, 1.4–1.5 mm.

Sciara (Lycoriella) molokaiensis Grimshaw (figs. 74a–c).

Sciara Molokaiensis Grimshaw, 1901, Fauna Hawaiiensis 3(1):2.

Sciara (Lycoriella) stonei Shaw, 1952, Proc. Haw. Ent. Soc. 14:495. **New synonym.**

Endemic? The most abundant lowland species on all of the main islands (type locality: "Molokai Mts., 6,500 ft." The elevation is an error—the highest point on Molokai is 4,970 ft.).

Type in the British Museum (Natural History).

This species was based upon one female specimen and has been unrecognizable from the original description. Shaw separated it by noting that the scape and pedicel are yellow and the flagellum all black. Actually the first flagellar segment is often yellowish, and the color of the antenna is of little value in distinguishing this species.

I compared specimens from the mountains of Molokai with the type in the British Museum and designated three females and one male (from Puu Kolekole and Maunawainui) as homotypes; the identity of the species was established from these. I also have studied the type series of *S. stonei* Shaw (Shaw collection, to be deposited in the U.S. National Museum).

S. molokaiensis is distinguished from other Hawaiian species by the subshining black mesonotum, lack of a sensory structure on the first segment of the palps

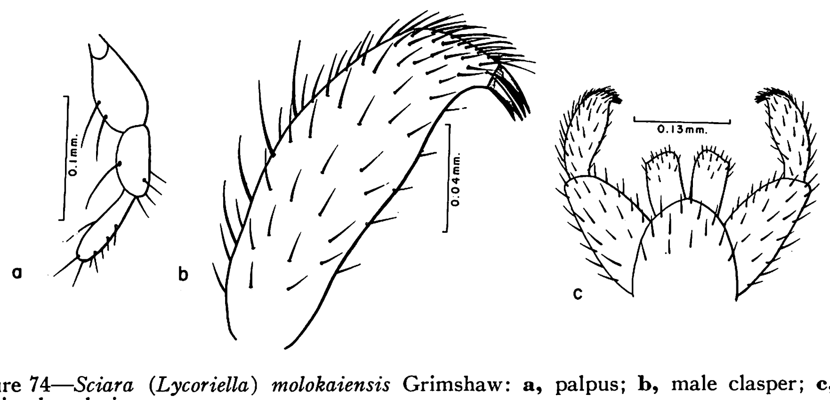

Figure 74—*Sciara (Lycoriella) molokaiensis* Grimshaw: **a,** palpus; **b,** male clasper; **c,** male genitalia, dorsal view.

(fig. 74a), and by the four subapical spines on the claspers (dististyli) (fig. 74b). The third segment of the palpus is about one-half longer than the second (fig. 74a) and is often capitate in shape. The first two antennal segments are yellow, the first flagellar segment is tinged with yellow basally and is sometimes all yellow. The pleura and genitalia are brown to black. The genitalia are as in figure 74c. The "peculiar hook-like structure" at base of dististylus referred to by Shaw seems to be present on all of our species. I do not consider it distinctive.

Length: body, 1.5–2.25; wings, 1.85–2.75 mm.

This species is attracted to lights in large numbers. At the University of Hawaii approximately 85–90 percent of the sciarids in the light-trap collections have been this species.

Sciara (Lycoriella) prominens Hardy (figs. 75a–b).
Sciara (Lycoriella) prominens Hardy, 1956, Proc. Haw. Ent. Soc. 16:83.

Endemic. Oahu (type locality: Pupukea) and Hawaii. All of the specimens have been taken in the mountains from 2,000–7,000 feet in elevation.

Type in the B. P. Bishop Museum.

Fitting in the *hardyi* Shaw complex of species because of the predominantly dark coloration, but the male genitalia are very different from any other known *Sciara* in our fauna (fig. 75b). The females resemble those of *S. hoyti* Hardy and are differentiated by the characters given under that species. The antennae and palpi are entirely dark-colored. The flagellar segments are about three times longer than wide. The first segment of the palpus lacks a sensory structure and is strongly attenuated at the base. The thorax is dark brown to black on the dorsum, lighter brown on the sides. The wing venation is as in figure 75a. The abdomen is entirely dark brown. The male claspers are about three times longer than wide and about equal in length to the ninth sternum; each has a series of small spines along inner margin and at apex, besides the large submedian spine (fig. 75b). The ninth tergum is gradually tapered, rounded at apex, and it extends almost to apices of ninth sternum (basistylus). The male genitalia closely resemble those of *Sciara forceps* Pettey (1918:328, fig. 1), but that species has the radius and medius setulose and would fit in a different subgenus.

Length: body, 2.0 mm.; wings, 1.7–1.85 mm.

Sciara (Lycoriella) radicum Brunetti (figs. 75c–e).
Sciara radicum Brunetti, 1912, Fauna of Brit. India, p. 139.

Oahu.

Immigrant. Described from Calcutta, India, and recorded from England, Samoa, Marquesas, and Fiji by Edwards (1928b:33).

Type in the Indian Museum, Calcutta.

I have compared specimens from Oahu with specimens from Samoa and they fit the species recorded as *radicum* by Edwards. He had compared the series from Samoa and Fiji with Indian specimens in the British Museum and concluded that they were the same.

The species superficially resembles *S. spatitergum* Hardy very closely. The thorax is predominantly reddish with the mesonotal markings as in *spatitergum* and *garretti* Shaw but with the lower three-fifths of the sternopleuron discolored with brown and the upper portion yellow as in *garretti*. This latter character may not be consistent; the extent of discoloration on the sternopleura varies somewhat in the specimens which have been studied. *S. radicum* is distinguished from *garretti* by the lack of a sensory structure on the first segment of the palpus and by the very different genitalia as shown in figures 70f and 75c. The palpi are very similar to those of *spatitergum*, but the third segment is somewhat shorter and thicker, being two times longer than wide (fig. 75e) rather than three times longer than wide (fig. 77a). The male genitalia are strikingly different. The ninth tergum is very short, not extending over half the length of the sternum (basistyli); the claspers are more slender, rather square-tipped, with the spines arranged as in figure 75c. In *spatitergum* the ninth tergum is greatly enlarged, swollen, and extends nearly to the apices of the sternum. The claspers are short and thick and somewhat pointed at apices (fig. 77b). The specimens of *radicum* which I have studied have a slightly raised portion in the middle of the underside of each tarsal claw. It approaches the *Phorodonta* character of having the claws toothed, yet is hardly developed into a distinct tooth (fig. 75d). Edwards stated that "the male claspers are very short"; this statement would not fit the specimens I have seen.

Length: body: *in situ*—1.25–1.5 mm., on slide—1.75–1.9 mm.; wings, 1.55 mm.

Brunetti (1912:140) found this species breeding in decaying lily bulbs and gave a few notes concerning its biology and mating behavior.

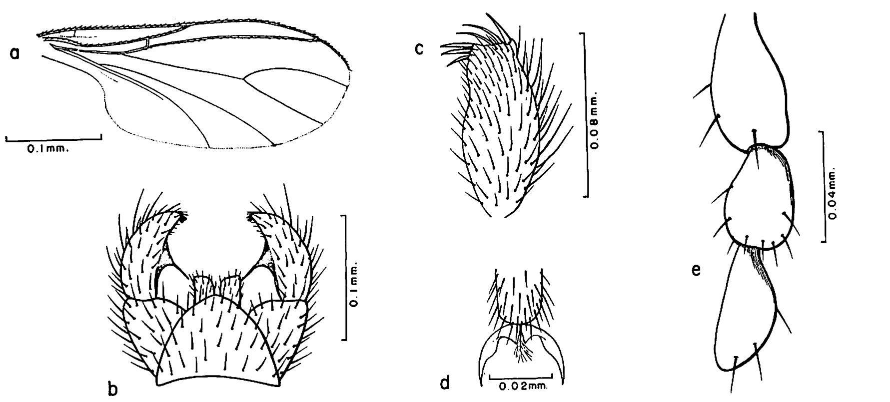

Figure 75—*Sciara* (*Lycoriella*) *prominens* Hardy: **a,** wing; **b,** male genitalia, dorsal view (*Lycoriella*) *radicum* Brunetti: **c,** male clasper; **d,** tarsal claw; **e,** palpus.

Sciara (Lycoriella) solispina Hardy (figs. 76a–e).

Sciara (*Lycoriella*) *solispina* Hardy, 1956, Proc. Haw. Ent. Soc. 16:84.

Endemic. Hawaii (type locality: Kaula Gulch, north slopes of Mauna Kea, 7,000 ft., elevation).

Type in the B. P. Bishop Museum.

Fitting in the complex of species which have the body and antennae entirely dark brown to black. It differs from all known species of *Sciara* from Hawaii by having the male claspers terminating in a single strong spine (fig. 76c).

The flagellar segments of antennae are approximately three times longer than wide. The palpi are brown, tinged with yellow, the basal segment has a large conspicuous sensory structure near the apex (this is a deeply excavated hollow with a somewhat narrower opening); the third segment is rather short, slightly less than one-half longer than the second (fig. 76a). Thorax dark colored with no distinct vittae on mesonotum. Apex of front tibia anteriorly with a rounded patch of dense hairs separated from the usual hair coating by a narrow hairless area (fig. 76e). Wings as in figure 76b. Genitalia as in figures 76c and d. Ninth sternum with a small tuft of setae on the median ventral line. The ninth tergum is narrow and rather elongate, about two times longer than wide. The claspers are rather slender, the inner margin straight; each clasper terminates in a strong bristle (fig. 76c).

Length: body, 2.0 mm.; wings, 1.5 mm.

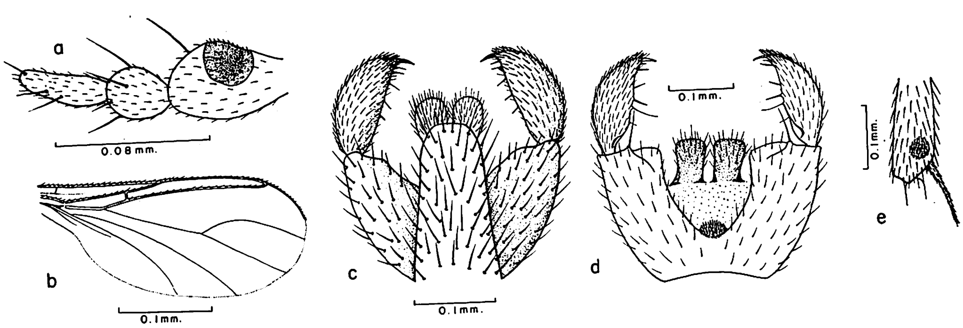

Figure 76—*Sciara* (*Lycoriella*) *solispina* Hardy: **a**, palpus; **b**, wing; **c**, male genitalia, dorsal view; **d**, male genitalia, ventral view; **e**, apex of front tibia.

Sciara (Lycoriella) spatitergum Hardy (figs. 77a–c).

Sciara (*Lycoriella*) *spatitergum* Hardy, 1956, Proc. Haw. Ent. Soc. 16:85.

Endemic. Oahu (type locality: Honolulu), Maui, Molokai, and Hawaii; probably on all of the main islands. A very common species at light; some specimens have been reared from rotting sugarcane, rotting sweetpotatoes, and from coffee grounds.

Type in the B. P. Bishop Museum.

This is the species which Shaw (1952:492, fig. 4) figured as *S. laffooni* Shaw, "described from two males from light trap . . . in Honolulu." I have studied the type and the paratype and found that these are both specimens of *S. garretti* Shaw (equals *S. johannseni* Shaw, *nec johannseni* Enderlein). They are mounted on paper points, but the diagnostic characters are obvious and I have made a

slide mount of the paratype. Another male specimen was in the collection returned by Shaw; it consisted of one wing and the abdomen mounted on a slide. This specimen was not designated as a paratype, but is obviously the specimen figured by Shaw as *laffooni*. This specimen represents a good species, but the name *laffooni* is not available for it since the type is a synonym.

S. spatigergum closely resembles S. garretti Shaw in coloration and mesonotal markings. It is distinguished by the lack of a sensory structure on the first segment of the palpus (fig. 77a), by the all-yellow lower half of pleura, and by the shape and development of the genitalia (fig. 77c). It also closely resembles *S. radicum* Brunetti, but the male genitalia are very different.

The scape, pedicel, and sometimes the basal segment of the flagellum are yellow, antennae otherwise brown. The palpi are as in figure 77a. The mesonotum is largely yellow, brown on the sides and sometimes on hind portion in front of scutellum. It has a brown vitta down each dorsocentral area from anterior margin and nearly coverging before the scutellum; a faint (often lacking) vitta extends down the middle of the mesonotum. The sternopleura, hypopleura, and metapleura are yellow; the remainder of the pleura are brown. The genitalia are yellow and the very large tergum is readily visible *in situ*. The ninth tergum is broadly expanded and very greatly developed compared to other Hawaiian sciarids. Each clasper (diststylus) has one apical and four subapical spines (fig. 77b).

Length: body and wings, 1.4–1.5 mm.

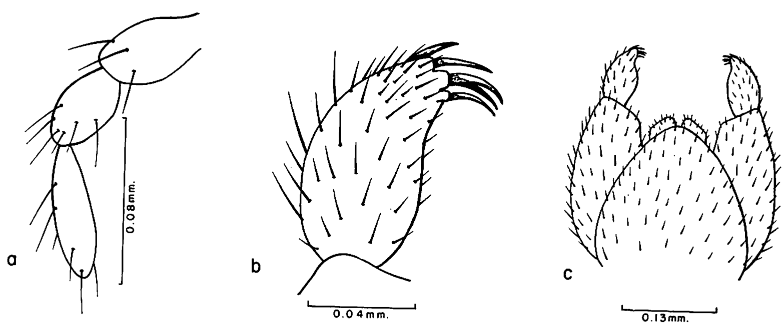

Figure 77—*Sciara* (*Lycoriella*) *spatitergum* Hardy: **a,** palpus; **b,** male claspers; **c,** male genitalia, dorsal view.

Genus **SCATOPSCIARA** Edwards

Sciara (*Scatopsciara*) Edwards, 1927, Trans. N. Zealand Inst. 57:798.

Scaptosciara Frey, 1942, Not. Ent. 22:34; 1948, Not. Ent. 27:69. Shaw, 1953, Proc. Haw. Ent. Soc. 15:29. (Misspellings of *Scatopsciara* Edwards).

This genus is characterized by having the mid and hind tibiae with only a single apical spine (the other rudimentary). Frey (1948:69) further characterizes

the genus *sens. str.* as having veins M_1 and 2 longer than M_{1+2}, the mesonotum polished black, the eye bridge with only two or three rows of facets, and the r–m crossvein distinctly bristled. I believe his concept to be too restricted; the genotype is the only species I know which fits these characteristics.

Type of genus: *S. quinquelineata* Macquart (syn. of *vitripennis* Meigen).

Subgenus **UDDMANIELLA** Frey

Scaptosciara (*Uddmaniella*) Frey, 1948, Not. Ent. 27:69.

A change of name for *Uddmania* Frey, 1942, Not. Ent. 22:38; *nec* Bergroth, 1915, Ann. Mag. Nat. Hist. (8)15:487. *Uddmannia* Frey 1948, Not. Ent. 27:69, is a misspelling. Note also that Frey misspelled the generic name; it should be *Scatopsciara*.

Frey characterized this subgenus as differing from typical *Scatopsciara* by the dull-colored mesonotum, shorter M_1 and 2, and the bare or sparsely bristled r–m crossvein.

Seven European species fit in this subgenus and probably *S. unicalcarata* Edwards from New Zealand also belongs here.

Type of subgenus: *S. pusilla* Meigen.

Scatopsciara (Uddmaniella) nigrita Hardy (figs. 78a–a–d).
Scatopsciara (*Uddmaniella*) *nigrita* Hardy, 1956, Proc. Haw. Ent. Soc. 16:86.

Endemic. Oahu (type locality: Palolo Valley) and Hawaii. The species is rather common at lights, on windows, and in rotting vegetation.

Type in the B. P. Bishop Museum.

A small dark brown to black species apparently related to *S. unicalcarata* Edwards from New Zealand. It differs (as compared with the original description) by being smaller, body 1.7 mm., not 3.0 mm.; the tibial spurs are longer, about one-half longer than the width of the tibia, not about "half as long as tibial diameter"; the r–m crossvein is over two times longer than basal section of M, not "about as long"; and veins M_1 and 2 diverge toward wing tip, not "straight and parallel." In Frey's key to the species of northern Europe (1948:69) it runs in the section with *S. calamophila* Frey and *leucoptera* Frey, but it is very different from either of these species.

Male antenna entirely dark colored. The flagellar segments, not counting the constrictions, are one-half longer than wide (fig. 78b). First segment of palpus nearly two times longer than wide and lacking a sensory structure. Second segment just slightly longer than wide and the third just a little longer than second and about one-half longer than wide (fig. 78a). Eye bridge, four facets wide. Thorax dark brown to black. Mesonotum with a narrow rufous to yellow line down each dorsocentral row. Wings as in figure 78c. Front tibia with a very small comb on anteroventral apex near insertion of the spur. The single spur of each hind tibia is one-half longer than the width of the tibia, and the basitarsus is about two-fifths the length of the tibia. The ninth tergum is twice as wide as long; its posterior

margin is gently convex. The ninth sternum is deeply concave on its hind margin, cleft nearly to the base of the segment. The claspers are two times longer than wide, somewhat tapered at the apex, and armed with one moderately strong apical and four or five subapical spines (fig. 78d).

Length of male: body, 1.6–1.7 mm.; wings, 1.3–1.4 mm.

Length of female: body, 2.0 mm.; wings, 1.75 mm.

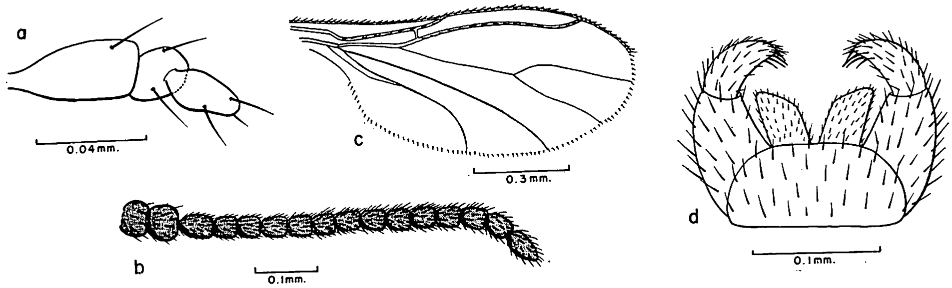

Figure 78—*Scatopsciara* (*Uddmaniella*) *nigrita* Hardy: **a,** palpus; **b,** antenna; **c,** wing; **d,** male genitalia, dorsal view.

Genus **HYPERLASION** Schmitz

Hyperlasion Schmitz, 1919, Tijd. v. Ent. 61:96.

This has been previously treated as a synonym of *Scythropochroa* Enderlein (see Frey, 1942, 40–41), but Dr. R. Tuomikoski has recently informed me that *Hyperlasion* is certainly not a synonym of *Scythropochroa*. He said that *Hyperlasion* is characterized by the deep sensory excavation of the first palpal segment and by having no clearly defined hair patch or comb at the apex of the front tibia.

This genus is readily differentiated from other sciarids in Hawaii by the distinctive, one-segmented palpi (fig. 79c) and by the very short tibial spurs which are about equal in length to the diameter of the tibia.

Dr. Tuomikoski has indicated that *Ceratiosciara* Enderlein (1911, Arch. f. Naturgesch. 77(1), Suppl. 3:183) is probably an older name for *Hyperlasion*. But he has not yet seen Enderlein's type and cannot be certain.

The genus (sens. str.) contains but two known species. Dr. Tuomikoski has recently (in correspondence) found *H. viridiventris* (Frey) to be conspecific with *H. wasmanni* Schmitg.

Type of genus: *Hyperlasion wasmanni* Schmitz.

Hyperlasion magnisensoria (Hardy), **new combination** (figs. 79a–d).
Scythropochroa magnisensoria Hardy, 1956, Proc. Haw. Ent. Soc. 16:89.

Endemic. Oahu (type locality: Kuliouou Valley, 1,500 ft.), Maui, Molokai, Hawaii, and Lanai. This species occurs in the mountains from 1,500–7,000 feet in elevation.

Type in the B. P. Bishop Museum.

This species fits in the group of *Scythropochroa sens. lat.* (of Frey, 1942) which has the base of vein M_{3+4} plus Cu_1 shorter than the base of M rather than longer, as in the type, the Paleartic species, and *S. nitida* Edwards from New Zealand. It superficially seems more closely allied to *S. samoana* Edwards than to any other species known to me. *S. samoana*, however, probably lacks the deep sensory excavation on the first palpal segment and probably it has a clearly defined hair patch or comb at apex of front tibia. *S. samoana* differs strikingly by being three times larger (body, 5.5 mm. rather than 1.5 mm.); by being predominantly black colored rather than rufous to brownish red; and the wing venation differs considerably in the two species. In *magnisensoria* vein R_1 is about half as long as R, not longer than R, and ends well before the fork of M_{1+2}, not beyond the fork; M_{1+2} is just slightly longer than M_2, not one-half longer, and R_{4+5} ends slightly before level of tip of M_2, not beyond.

In the male the eye bridge is two facets wide over most of the vertex, but is briefly interrupted on the upper portion by a space equal to the combined width of about three facets. The antennae are yellow, tinged with brown. The flagellar segments, not counting the short constrictions, are approximately two times longer than wide (fig. 79a). The palpus is short and thick, scarcely longer than wide, and has a large sensory pit, or excavation, occupying nearly the entire apex (fig. 79c). The front tibia has no clearly defined hair patch or comb at apex. The thorax is entirely rufous, tinged slightly with brown. The wing venation is as in figure 79b and the male genitalia as in figure 79d. The ninth tergum is short and broad, nearly twice as wide as long. The claspers are a little over two times longer than wide and have four subapical spines and two spines near median surface below, besides a row of strong bristles around the apex (fig. 79d).

Length of body and wings of both sexes: 1.3–1.5 mm.

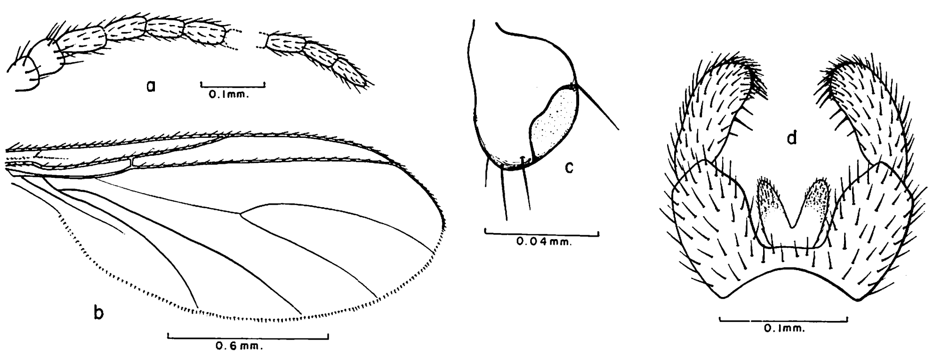

Figure 79—*Hyperlasion magnisensoria* (Hardy): **a,** antenna; **b,** wing; **c,** palpus; **d,** male genitalia, ventral view.

Genus **SPATHOBDELLA** Frey

Spathobdella Frey, 1948, Not, Ent. 27:72.

This genus is distinguished from *Plastosciara* Berg by having the second seg-

ment of the palpus elongate, at least as long as the first. The group contains but two known species (*S. cunctans* (Winnertz) and *detrita* Frey), both from Europe. One species at hand apparently fits here; I see no satisfactory way to separate it from *Spathobdella.*

Type of genus: *Sciara cunctans* Winnertz.

Spathobdella setigera, new species (figs. 80a–c).

This is readily distinguished from the other two known species by lacking the single strong apical or subapical spine on the male clasper.

MALE. *Head:* Eye bridge composed of two rows of facets, eyes rather thickly haired. Antennae yellow-brown, the nodes of the flagellar segments one-half longer than wide; the attenuated portions of the segments about one-third as long as the nodes. The first segment of the palpus oblong, about half again as long as wide. The second segment three times longer than wide and slightly longer than the first (fig. 80a); it has three apical setae and four setae on the dorsal surface. *Thorax:* Dark brown to black. Dorsocentral and marginal setae well developed on mesonotum, acrostichals lacking except for a few small setae near front margin of thorax. Scutellum apparently with four to six moderately strong setae on hind margin (broken off on one side on the specimen at hand). *Legs:* Largely yellow, coxae and trochanters tinged with brown. Spurs of hind tibiae one-half times longer than the diameter of the tibia. Hind basitarsi about half as long as the tibiae, the latter with a row of moderately strong, erect setae extending down the posterodorsal surface on the apical two-thirds of the segment. *Wings:* Slightly fumose, costa extending four-fifths the distance to the apex of vein M_1. R_1 equal in length to the r–m crossvein and one-third longer than the base of M. The base of $M_{3+4} + Cu_1$ about four-fifths as long as M. Crossvein r–m with three or four setae. M_{1+2} slightly longer than M_2. *Abdomen and genitalia:* Dark brown to black, clothed with brown to black setae. The ninth tergum one-half wider than long, gently convex on the hind margin, and with the setae distributed over the posterior half of the segment (fig. 80c). The sternum short and broad, not much longer than the claspers. The latter about two and one-

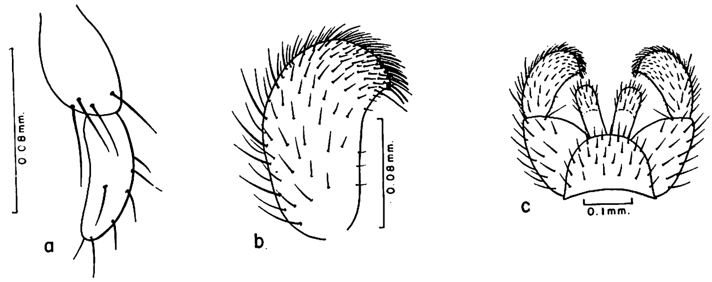

Figure 80—*Spathobdella setigera* n.sp.: **a,** palpus; **b,** male claspers; **c,** male genitalia, dorsal view.

half times longer than wide, blunt at apices, with no spines but with the apices densely covered with hairs (fig. 80b).

Length: body, 2.0 mm.; wing, 1.7 mm.

FEMALE. Unknown.

Holotype male: Keanakolu, Hawaii, 5,200 ft.; October 29, 1952 (C. P. Hoyt). Type returned to the B. P. Bishop Museum (Type No. 2487).

Family CECIDOMYIIDAE Newman
Gall Midges

Cecidomiites Newman, 1834, Ent. Mag. 2:386.
Cecidomidae Macquart, 1838, Dipt. Exot. 1(1):79; also 1838, Mem. Soc. Sci. Lille 1(2):83.
Cecidomyides Westwood, 1840, Intro. Modern Class. Ins., London 2:518.
Cecidomydae Rondani, 1856, Dipt. Ital. 1:41.
Cecidomyidae Schiner, 1864, Verhandl. Zool.-Bot. Gesellschaft, Wien 14:211.
Cecidomyiidae Kertesz, 1902, Cat. Dipt. 2:1.
Itonidae Felt, 1911, Jour. N. Y. Ent. Soc. 19:31.
Itonididae Felt, 1912, Jour. N. Y. Ent. Soc. 20:102.
For more complete synonyny see Handlirsch, in Schröder (1925:956).

The family name comes from the Greek kekidos, a gall, plus myia, fly, and refers to the galls formed by many of the species.

Rather small, fragile flies, usually with slender legs and antennae; characterized by having the thickening of the costa continuous around the wing, becoming weakened and gradually evanescing on the hind margin. The costa is often broken for a short way beyond tip of R_{4+5}; the thickening beyond the radial veins is less distinct in the Lestremiinae. Most of our species (excepting the subfamily Lestremiinae) may be recognized by the reduced wing venation, there being but three to four longitudinal veins and no crossveins. The antennae are also very characteristic, consisting of numerous cylindric, subglobose petiolate or binodose segments usually bearing prominent whorls of long hairs; the males usually have twisted and looped filaments, called circumfila, (fig. 98a) or have verticili on the segments. Some Lestremiinae very closely resemble specimens of Sciaridae and some (especially *Anarete*) look very much like scatopsids. Enderlein (1911:125; 1936:59) has treated Lestremiinae as a subfamily of Sciaridae, and, according to Edwards (1938:23), "the genus *Anarete* has sometimes been placed in the Scatopsidae, while two apparently scatopsid genera have been included by Felt in the Lestremiinae and a species of *Lestremia* has been described by Malloch in the Sciarine genus *Zygoneura*." The Lestremiinae are differentiated from these other groups by having the costal margin thickened all around the wing, the wing membrane hairy, and the flagellar segments of antennae with crenulate whorls or verticili (even if short). The development of the antennal segments and their sensory structures are different (figs. 59b, 70a, 82a, and 87e) as are the genitalia

(figs. 58b, 70e, and 82c). There are at least slight differences in details of the wing venation, i.e., vein Cu_1 never quite reaches wing base (fig. 83b). Also the eyes are always bare, whereas they are always haired in the scatopsids and usually so in the sciarids. The thorax usually has distinct dorsocentral hairs in Lestremiinae; these hairs are always present in sciarids and are lacking in scatopsids. The coxae are rather short and the tibiae are slender without spurs; the scatopsids have similar legs except that the tibiae are distinctly widened from base to tip, and the sciarids have the coxae elongate and the tibiae spurred. Vein Cu_1 is separate from Cu_2 and extends to the wing base at least in Scatopsinae, and it arises from Cu_2 near wing base in Sciaridae. The male genitalia of *Lestremia* and sciarids are rather primitive and simple; while those of the scatopsids have the eighth segment atrophied and the genitalia complex (fig. 58b, 61d).

Little is known of the biologies of the Hawaiian species; but it is quite obvious that the common name, gall midge, is not particularly appropriate for our fauna since we have but one species which is definitely known to be a gall former (*Diarthronomyia chrysanthami* Ahlberg). *Parallelodiplosis cattleyae* (Molliard), a gall former on roots of *Cattleya* orchids, has been intercepted at Honolulu a number of times in quarantine, but is not known to be established here. The members of the family have very diversified feeding habits, and many species are of considerable economic importance because of their injurious effect on a wide variety of plants. It is probable that the bulk of the Hawaiian species are predators or scavengers. Some of them obviously prey upon aphids, mealybugs, and probably other insects and mites; many of our species apparently feed as scavengers in decaying organic matter. Of the known herbivorous species, we have at least one blossom midge (miner), one which feeds on growing seeds of grasses and grains, and apparently several species which feed on mushrooms and other fungi. *Contarinia sorghicola* Coquillett feeds on growing seeds of sorghum, Johnson, and Sudan grasses. *C. maculipennis* Felt is the common blossom midge in Hawaii. It attacks the blossoms and buds of tomato, hibiscus, pikake (*Jasminum sambac*), and other blossoms. An undetermined species was recorded by Timberlake (1918:380) ovipositing in the terminal buds of one of the native trees, *Pelea clusiaefolia*, on Mt. Kaala, Oahu. Other phytophagous cecidomyiids in Hawaii include species reared from "lantana berries," "ex *Straussia*," "ex pineapple," "avocado flowers"; an undetermined species, recorded by Bridwell (1919:42), reared from *Livistona* palm seeds which had been partially destroyed by scolytid beetles (this is possibly a predator or scavenger); and also species reared from spores of rust on sorghum leaves and geranium, and from other fungi. Several species of scavengers are present in our fauna. The Lestremiini are probably scavengers; species of other groups have been reared from rotting bark and fruits and from various other types of decaying vegetation. We obviously have a number of predacious species represented, several of which are perhaps of considerable importance in biological control of various pests. *Phaenobremia meridionalis* (Felt) has been recorded feeding on the sugarcane aphid (*Aphis sacchari* Zehnter), the cabbage aphid (*Brevicoryne brassicae* Linnaeus) and the corn aphid (*Aphis maidis* Fitch); *Lobodiplosis pseudococci* Felt feeds on the pineapple mealy-

bug (*Dysmicoccus brevipes* Cockerell); *Arthrocnodax walkeriana* Felt has been reared from three sugarcane mealybugs (*Trionymus sacchari*) Cockerell, *Dysmicoccus boninsis* (Kuwana), from *Pseudococcus adonidium* (Linnaeus); *Trisopsis oleae* Kieffer preys upon *Pedronia hawaiiensis* Ferris, an endemic mealybug; *Dicrodipiosis guatemalensis* Felt was imported into the State as a predator for the pineapple mealybug but is not known to be established. A species of *Lestodiplosis* reared from poultry manure is very probably a predator on fly larvae and other insects living in the manure; others of our gall midges very probably feed on mites and various small insects. For the rest of the world, over 50 species are known to prey upon aphids and over 50 on scale insects (about half on mealybugs): three species are known to prey upon aleyrodids; five are predators and parasites of psyllids; one is an internal parasite of a tingid bug (refer to Barnes 1929b, 1930, and other Barnes' papers); at least two species have been recorded feeding on thrips; many feed on other gall midges and many are predators on mites. Elago (1940: 85–86) suggested the use of gall midges in the biological control of mites. Experimenting with *Silvestrina tyrophagi* Dombrowski, he noted that when this species was introduced into about one-half ton of hemp seed infested with *Tyrophagus castellanii* (Hirst), the mite population was reduced 78.5 percent in one month.

According to Barnes (1954:769), only four known species of endoparasitic gall midges have been recorded in the literature, "although a few other unidentified species have been found." *Endaphis perfidus* Kieffer, and probably other species of *Endaphis*, parasitize aphids in Europe and possibly other parts of the world. [Note: the species described as *Endaphis* by Felt were not endoparasites and all have been transferred to other genera according to Barnes.] *Endopsylla agilis* de Meijere is an endoparasite of several species of *Psylla* in Europe. *Endopsylla endogena* (Kieffer) is an endoparasite of a tingid bug (*Stephanitis pyri*) (Fabricius) in Europe and is the only known species to pupate within the body of the host. *Pseudendaphis maculans* Barnes is an endoparasite of *Toxoptera aurantii* (Boyer de Fonscolombe), *Aphis gossypii* Glover, and other aphids in Trinidad.

The larvae of cecidomyiids are usually stout, rather spindle-shaped, and vary in color from white to yellowish, orange, pink, or bright red. The cuticle is rather smooth, the body usually has 13 segments, and there is one pair of spiracles on the thoracic region and one pair each on the first 7 or 8 abdominal segments. The larvae ordinarily can be recognized by their coloration and usually by the presence of a sclerotized plate or bar (spatula or breastbone) extending longitudinally on the venter of the prothoracic segment. This structure varies considerably in size and shape and presents good diagnostic characters for separating many of the species. Barnes (in correspondence), indicates that larvae that are going to multiply paedogenetically have no spatula, but that it is present in those which are going through normal development. The larvae of *Contarinia*, and at least some other Contariini, are saltatorial; most Cecidomyiini larvae apparently do not jump, but an exception to this is *Pseudendaphis maculans* Barnes, which parasitizes aphids in Trinidad.

The phenomenon of paedogenesis occurs in some genera (Barnes, 1929c). Some may reproduce for several generations by larval parthenogenesis (the young larvae develop inside and later devour the body of the mother larva) before the adults appear and bisexual reproduction is resumed. This phenomenon has not been observed in Hawaii, but it is probable that our species of *Mycophila* and *Oligarces* reproduce in this manner.

The classification of members of this family is difficult, mainly because of their fragility and the difficulty in obtaining perfect specimens for study, but also due to the lack of monographic studies, the inadequate descriptions (predominantly without figures), and the tremendous volume of literature scattered throughout the zoological journals of the world. The literature on this family is voluminous. Kieffer (1900) cited 828 references in his preliminary *Monographie des Cecidomyides D'Europe et D'Algerie*, and perhaps the bulk of the work on this group has been done since 1900. There are few major monographic studies of this family, and, in spite of the tremendous numbers of papers which have been published, the great share of our knowledge has been gained from the works of comparatively few students. Until rather recently, Dr. E. P. Felt has been almost the only American worker on this family. Our early knowledge of the European fauna was based largely upon the works of J. J. Kieffer and E. H. Rübsaamen. Kieffer was perhaps the most prolific worker on the gall midges, but apparently he had some peculiar ideas regarding taxonomic procedures. According to Edwards (1938a:18), "It appears that for most of Kieffer's species no types exist. . . . Kieffer not only did not make types, but was not even interested in forming a collection: in the case of material collected by himself he usually destroyed the specimens after describing them; specimens sent him by others were returned to the senders." Since 1927, Dr. H. F. Barnes, Harpenden, England, has been the leading worker on the gall midges in Europe. His contributions on the biologies of the economic species have been especially outstanding. Dr. E. Möhn, Stuttgart, Germany, is now undertaking a monograph of this family for *Die Fliegen der Palaearktischen Region* and is also doing considerable work on the gall midges of other world areas; his recent monograph (1955) of the larvae of central Europe is a monumental piece of work. Dr. A. E. Pritchard, University of California (1947–1953), has made some important contributions to the American literature; Dr. R. H. Foote, U.S. National Museum, is now the leading American worker on this family. There are still vast areas of the world where practically nothing is known concerning the gall fly fauna. The Oriental species had scarcely been touched until the recent work by Dr. M. S. Mani, Agra (1950, 1952, 1953, 1954a, and 1954b), and Dr. S. N. Rao, Nagpur (1955). These men have made excellent contributions to our knowledge of the Indian species. The latter has recently published (1955) a catalog of the Oriental species. A. Skuse (1889) published a preliminary monograph of the Australian gall midges and described nearly 100 species from that continent. His descriptions, however, were based upon specimens mounted on paper points and no details of the genitalia or other microscopic details are given. Most of his species probably will remain unrecognizable until the types are restudied in detail.

Only about a dozen species have previously been determined from all of Oceania (see Barnes, 1937). Seven of these have been recorded from the Hawaiian Islands. The present study includes 2 subfamilies, 7 tribes, 23 genera, and 30 species.

It appears that there are very few endemic gall midges in the Hawaiian fauna; I believe that most of our species have been introduced from other areas. This makes the taxonomy of our species especially difficult, since they could have come to us from almost any region of the world. In my study of this group it has not been possible for me to cover the world literature completely—this would be quite an impossible task unless several years were devoted to the study. I have attempted to cover all of the available major contributions and have called upon the assistance of specialists wherever this help was available. At best this can only be considered a very preliminary study of the Hawaiian gall midges. Many other species will surely be discovered when more concerted collecting is done throughout the Islands. Unfortunately the bulk of the material used in this study has been obtained from a few sources (light traps) mostly on the island of Oahu; this has been by far the most successful method of collecting gall midges. Aside from light trapping, the collecting methods used have not been satisfactory, and it has not been possible to obtain adequate light-trap samples from the other islands. Because of their fragility, the midges are easily damaged by other insects which are attracted to the light, and the samples must be sorted carefully to pick out the good specimens. We also collect specimens by sweeping or aspirating them from vegetation and by rearing; but it is difficult to get field-collected specimens into the laboratory in good condition unless specialized techniques are used. Ideally, one should go out with the sole purpose of collecting just gall midges, and the specimens should be killed and layered immediately after collecting and then mounted on minuten nadeln as soon as possible. The most satisfactory method of obtaining good specimes is by rearing them from their plant or animal host or from decaying organic matter. For the most part, I have not found it advisable to mount specimens on paper points unless special care is taken to avoid using an excess of glue; also, a water soluble glue should always be used. It is preferable to preserve part of each series in alcohol and mount part on minuten nadeln; to make good nadeln mounts, however, it is best that the specimens be prepared while fresh. For critical study, the midges must be mounted on microscope slides. Pritchard (1951:239) macerates the specimens (with wings removed) in KOH, dehydrates in methyl cellosolve, and mounts them in Canada balsam. Some other workers prefer to use alcohol for dehydration, mounting in balsam, euparal, or similar media. We have encountered considerable difficulty in finding a mounting technique which would give consistently good results. Following the recommended techniques, excessive shrinking and contortion has occurred in a high percentage of the specimens, making many of them worthless for study. Some of this difficulty is probably due to the condition of the specimen before mounting; some material in alcohol has been especially difficult to macerate or to mount without shrinkage. Also the fluctuations in humidity may have caused some of the difficulties; our dehydration media may have taken on moisture. For most of our preparations we have had to resort to chlorol hydrate–gum Arabic

mixtures (Hoyer's solution) for the bodies; the wings (clipped from the body) may be taken through into balsam without any difficulty. After drying in the oven for about six weeks, these Hoyer's solution mounts are sealed with ringing cement and it is hoped that they will be permanent preparations. It is very desirable to have dry mounts of wings made by placing them under a coverslip and sealing around the edges with balsam, euparal, or ringing cement. The venation is much more readily visible when the wings are dry than when mounted in fluids.

Some species of cecidomyiids are especially interesting subjects for cytological and genetical research. Dr. M. J. D. White (1950:5) stated that "the most anomalous of all genetic systems are those of the gall midges." For an excellent review of the cytological studies, with a complete bibliography, refer to White's paper.

The phylogeny and evolutionary development of the gall midges have been reviewed by Mani (1950). From his studies he concluded that the family Cecidomyiidae was not derived directly from the Mycetophiloidea and Bibionoidea but that the ancestral stock probably separated off "from the Protorhyphidae during the upper Lias. . . . The ancestral midges greatly resembled the Anisopodiodea and Mycetophiloidea and possibly had similar habits. The family became distinct probably during the late Cretaceous and early Eocene period. Due to the birth of the Angiosperms the ancestral midges changed the humus breeding habit to one of breeding in bark, leaves, etc. Then the plants began to react by producing gall growths, which in turn initiated a series of mutual modifications and adjustments in habits and structure both of the plant and of the midges." Dr. Mani pointed out that the cecidomyiids have arisen from a stock totally different from the sciarids and any resemblance to the later is merely due to parallelism and not to monophyletic decent.

These flies possess striking morphological characters for differentiating the genera and species, at least for the known Hawaiian species; there evidently are many exceptions to this in other areas where the identification of species of genera such as *Diarthronomyia* Felt, *Rhopalmyia* Rübsaamen, and others is based largely upon the host.

The most important taxonomic characters are found in the details of the antennae, palpi, wing venation, length of basitarsus, development of the tarsal claws and empodium, and in the characteristics of the genitalia. The structure of the eyes is useful in separating *Trisopsis* Kieffer and some genera of Micromyini (see figs. 87d and 107b). Only the members of the subfamily Lestremiinae possess ocelli; there may be three, two, or none present in species of this group. The antennae are very diversely modified throughout the family; the number of segments varies from 9 (in the males of *Anarete johnsoni* (Felt) and the females of *Mycophila fungicola* Felt) to 24 (in the females of *Porricondyla* sp.?). Most of the Hawaiian species have 14-segmented antennae. The scape and pedicel are usually normal in development, but, as in *Anarete*, the pedicel may be greatly enlarged (fig. 81a). The flagellar segments are strikingly modified in the males of most of the gall midges and for the most part are rather simple in development

in the females. The segments vary from simple nodes, with or without distinct stems, to those which are binodose (fig. 97a) or trinodose. The flagellar segments bear a great variety of sensory structures (probably both olfactory and auditory) ranging from mushroom-like or plate-like structures, thread-like bands girdling the segment, crenulate whorls and verticili, to greatly developed looped filaments, called circumfila (figs. 87e, 88c, 90a). For the purpose of consistency the fifth antennal segment is usually shown in the figures and is used for descriptive purposes. The palpi are normally four-segmented; our species of *Mycophila* has but two segments in each palpus, and our *Monardia* and *Trisopsis* have but three segments. The wing venation is characteristically reduced in the subfamilies other than Lestremiinae; sometimes it consists of only three longitudinal veins and usually with no crossveins. The subcostal vein is very poorly developed or lacking. Radius consists of two veins—a short R_1 and the extension of radial sector which apparently consists of R_{4+5}; this normally extends to or near the wing apex. The r–m crossvein is present but usually appears to be an extension of the base of vein R_{4+5}. The radial sector is ordinarily well developed in the more primitive groups and is lacking in the more specialized genera. The median veins are also rather well developed in the more primitive forms, with M_{1+2} forked in the Lestremiinae; M_{1+2} may be present or absent in the more specialized genera. The cubitus may consist of a simple or a forked vein (depending upon the genus involved) and one or two anal veins may be present, especially in the Lestremiinae (refer to figs. 81c, 89e, 90d). The legs are usually fragile and slender; they are shorter and stouter in the Lestremiinae. As pointed out in the key to follow, the basitarsi are very short compared to the second segment in the more specialized groups and are normal in development in the more primitive. The tarsal claws may be simple, strongly curved (fig. 105f), dentate (fig. 98j), serrate, or pectinate (fig. 83d). The degree of development of the empodium is also an important taxonomic character. It should be noted that the structure termed "puvillus" by Felt (1925, and other papers) should actually be the empodium. It is greatly developed in some genera and is rudimentary or absent in others. The genitalia, especially of the male, are of utmost importance in distinguishing species; it is impossible to separate most species without studying the male genitalia. The terminology of the genital structures is somewhat confused in the literature; a wide variety of terms have been used for the same parts. For the most part, I have followed Felt (1925:93–98) as modified by Pritchard (1947:5–6) and Edwards (1938a:21–23). The appendages of the ninth segment are the most conspicuous structures of the genitalia. The basal portions, or basistyli ("basiclasper" and "basiforceps" of Pritchard, 1947; "coxite" of Edwards, 1938a; "basal clasp segment" of Felt, 1925; and "basal forcipule" of Kieffer, 1913), are almost always joined ventrally on the anterior median margin. Each basistylus root bears a curved ventral arm which is connected with the sheath around the aedeagus (tegmen). Sometimes well-developed, densely haired lobes are present on the inner basal margin, and one Hawaiian species (*Lobodiplosis pseudococci* Felt) has a strong apical lobe on each basistylus (fig. 102d). The dististyli ("disticlasper" and "distiforceps" of Prichard; "style" of Edwards; "terminal clasp

segment" of Felt; "terminal forcipule" of Kieffer) are slender, usually shorter than the basistyli, variable in shape, and often each has one or two teeth at apex. The ninth tergum is developed, but there is no separate sternum on the ninth segment. The tergum is largely membraneous, but the posterior portion is usually sclerotized. The tenth (anal) segment is well developed in these flies and provides the most useful characters for separating genera and species. The tenth tergum usually consists of a sclerite bearing a pair of lobes (cerci) and his commonly been referred to in the literature as the "dorsal plate" by Kieffer, Felt, and other authors. The sternal portion of the tenth segment is represented by a setulose or finely pubescent area which may be a single plate or may be divided into lobes, lying directly beneath the tergum and directly above the aedeagus (fig. 105e); this has commonly been referred to in the literature as the "ventral plate." the aedeagus usually consists of a simple saddle-like sclerite or sheath covering, dorsally, the distal portion of the male genital duct and a rod-like intromittent structure. Edwards referred to the former as the "tegmen" or "penis-sheath"; the term tegmen seems to be the most appropriate of those which have been used in the literature. This structure was referred to by Kieffer as the "appendices ventraux," and Felt used the term "harpes" in referring to this covering over the penis. The intromittent organ lies directly beneath the tegmen and has been referred to in the literature as the "genital rod" by Edwards, Pritchard, and others; Felt used the term "style" and Kieffer called this the "stylet." The female genitalia are comparatively simple. The opening of the oviduct appears to be on the ninth abdominal segment and the ovipositor is usually rather short, consisting of a pair of apical lobes borne on the ninth tergum. The ovipositor, however, is variously modified throughout the family, and, in some genera and species, may be greatly extended. In *Contarinia*, and possibly other Hawaiian genera, the ovipositor is greatly elongated and needle-like, equal or greater than the length of the body. Of the Hawaiian gall midges, apparently only the genera *Mycophila* and *Monardia* (tribe Micromyini) possess sclerotized spermathecae.

For a thorough resume of the family, including economic importance, habits, morphology, and taxonomy, refer to Felt (1925 and 1929). For a more complete description of morphology and terminology, refer also to Pritchard (1947) and to Edwards (1938a). See Felt (1918a) for a key to American insect galls and Möhn (1955) for a comprehensive study of the gall midge larvae of central Europe. For information on the galls, refer to Felt (1918b and 1940) and to Mani (1952, 1953 and 1954a).

As used by Felt (1913:202, 1925:135) and others, the subfamily Heteropezinae is not a satisfactory grouping. It has included, according to Felt's definition, those which have the "metatarsus longer or shorter than the following segment; wings with not more than 3 long veins; crossvein and circumfila wanting." The group borderlines the subfamilies Lestremiinae and Cecidomyiinae, and the genera have characters common to one or the other; the only exception I see to this (from Felt's study) is that some genera lack circumfila on the antennae. Pritchard (1953:125) distributed the California genera of this group among the Lestremiinae

and Cecidomyiinae, according to the development of the first segment of the tarsus. Only two genera of this complex are at present known to be represented in Hawaii: *Johnsonomyia* Felt and *Porricondyla* Rondani; these fit in the tribe Epidoseini under Cecidomyiinae.

Pritchard has indicated (in correspondence) that the Heteropezinae question is still not settled, and it may be necessary to retain this subfamily for at least one tribe. He says that additional larval material will have to be studied before the status of the subfamily can be completely clarified.

Key to Subfamilies of Cecidomyiidae

ADULTS

1. Basitarsus longer than second tarsal segment... **Lestremiinae.**
   Basitarsus much shorter than second segment.. **Cecidomyiinae.**

LARVAE
(from Pritchard 1853:125)

1. Anus circular and located terminally on last segment...... .... **Lestremiinae.**
   Anus longitudinal and located on venter of last segment.... .... **Cecidomyiinae.**

Subfamily Lestremiinae Rondani

Lestreminae Rondani, 1840, Sopra Alc. Gen. Inset. Ditt., Mem. Soc. Serv. Ditt. Ital., Parma, p. 6. (Review in Isis von Oken, 1844:450).
Anaretina Loew, 1862, Mon. Dipt. N. Amer. 1:7.
Lestremina Skuse, 1889, Proc. Linn. Soc. N. S. Wales 3(1):47.
Lestremiinae Kertesz, 1902, Cat. Dipt. 2:3.
Lasiopteryxariae Kertesz, 1902, Cat. Dipt. 2:3.
Heteropezinae, in part, of many authors; see discussion in introduction.
For more complete synonymy see Handlirsch, in Schröder (1925:957).

The members of this subfamily may be differentiated from all other cecidomyiids by having the basitarsus longer than the second tarsal segment. According to Pritchard (1951:240), the larvae differ from those of other groups by having a simple, terminal, anal tube. Two tribes occur in Hawaii, Lestremiini and Micromyini. The former is characterized by having vein M_{1+2} forked and M_{3+4} present; also, the female lacks sclerotized spermathecae; vein Cu is not forked, and two ocelli are present. The Micromyini have vein M_{1+2} simple, M_{3+4} lacking, and vein Cu forked (fig. 87c); the female have sclerotized spermathecae, and three ocelli are present.

Pritchard (1951: 241) says the Lestremiinae have been reared from mushrooms, decaying wood and leaves, manure, moss, and from soil; "It is doubtful that any species feeds on living tissues of higher plants, although larvae have sometimes been found near plant roots or have sometimes been reared otherwise in connection with plants." Nothing is known of the habits of this group in Hawaii. Most of our specimens are collected at lights; they are sometimes collected by sweeping vegetation, by sweeping the ground litter in the mountains, and sometimes they are found on windows in the lowlands. For a monograph of the British species, with notes on exotic species, see Edwards (1938).

Key to Tribes and Genera and some Species of Lestremiinae

1. Vein M_{1+2} forked; M_{3+4} present and vein Cu not forked (fig. 81c). Female without a sclerotized spermatheca. Tribe **Lestremiini** 2

   M_{1+2} simple; M_{3+4} and vein Cu forked (fig. 87c). Female with at least one sclerotized spermatheca. Tribe **Micromyini** 3

2. Male antenna 8–9-segmented, pedicel greatly enlarged; flagellar segments without crenulate whorls and not attenuated apically, most are broader than long (fig. 81a). Third costal section (cell R_1) shorter than second and much broader than cell R. Vein R_1 oblique (fig. 81c).. **Anarete johnsoni** (Felt).

   Male antenna with 14–16 segments; flagellar segments with crenulate whorls in the male and attenuated apically, much longer than wide. Third costal section longer than second and about as wide as cell R. R_1 approximately parallel with Rs.................. **Lestremia** Macquart.

3. Palpus 2-segmented. Male antenna 11-segmented. Vein Cu_2 extending to wing margin (fig. 87c). Male diststylus acutely pointed at apex (fig. 87a). No genital rod present. Female with one spermatheca. . **Mycophila fungicola** Felt.

   Palpus 3-segmented. Male antenna 14-segmented. Cu_2 short (fig. 86b). Male diststylus short, rounded at apex (fig. 86a). Genital rod present. Two spermathecae present.................................... **Monardia recondita** n. sp.

Tribe Lestremiini Kieffer

Lestremides Kieffer, 1898, Bul. Soc. Hist. Nat. Metz (ser. 2) 8:52.
Lestremiariae Kieffer, 1900, Ann. Soc. Ent. France 69:451.

Lestremiinariae Felt, 1908, Bul. N. Y. State Mus. 124:308.
Lestreminariae Felt, 1911, Jour. N. Y. Ent. Soc. 19:31.
Lestremiini Enderlein, 1911, Arch. Naturg. 77:189.
Lestremiinae Enderlein, 1936, Tierw. Mitteleur. 6:59.

The members of this tribe are differentiated from other Lestremiinae by having vein M_{1+2} forked, Cu simple, the anal vein free and sometimes short, vein M_{3+4} free and not arising from M, usually two ocelli, but sometimes ocelli lacking, and female without sclerotized spermathecae. Apterous or brachypterous species occur in other areas; where the wings are short or lacking, the members of the tribe are recognized by having two ocelli and by lacking the sclerotized spermathecae in the female.

Very little is known about the habits of species of this tribe. Edwards (1938:24) indicated that most are probably xylophagous or saprophagous; also, some species are known to feed on fungi.

For a monograph of the North American species, see Pritchard (1951).

Two genera are known to occur in Hawaii: *Anarete* Haliday and *Lestremia* Macquart.

Genus **ANARETE** Haliday

Anarete Haliday, 1833, Ent. Mag. 1:156.
Molobraea (*Anarete*) Loew, 1850, Dipt. Beitrag. 4:32.
Anarete (*Pseudanarete*) Kieffer, 1906, Ann. Soc. Sci. Bruxelles 30:342.
Microcerata Felt, 1908, Bul. N. Y. State Mus. 124:308.
Limnopneumella Enderlein, 1911, Arch. Naturg. 77:195.
Limnopneuma Enderlein, 1911, Arch. Naturg. 77:196.

This genus is near *Conarete* Pritchard, and both are distinguished from other Lestremiini by having a reduced number of segments in the antennae. The number ranges from 8 to 12, rather than 16 as in the other genera. *Anarete* are distinguished from *Conarete* by lacking distinct stems and crenulate whorls on the flagellar segments on the antennae; also the extensions at the base of the aedeagus (tegman of Edwards, Pritchard, and others) extend anteriorly rather than laterally.

Only one species is known from the Hawaiian Islands.

Type of genus: *Anarete candidata* Haliday.

Anarete johnsoni (Felt) (figs. 81a–d).

Microcerata johnsoni Felt, 1908, Bul. N. Y. State Mus. 124:310.
Microcerata cockerelli Felt, 1908, Bul. N. Y. State Mus. 124:310.
Microcerata spinosa Felt, 1913, Bul. N. Y. State Mus. 165:145.
Microcerata iridis Cockerell, 1914, Jour. Econ. Ent. 7:460.
Microcerata aldrichii Felt, 1915, Canad. Ent. 47:226.
Anarete johnsoni (Felt) Edwards, 1929, Ent. Mo. Mag. 65:14.
Anarete heracleana Edwards, 1938, Proc. Roy. Ent. Soc. Lond. 7(Ser. B):29.

Oahu, Kauai, and Maui. Probably present on all of the main islands. Very common in light-trap catches. It has also been collected in large numbers from sweeping mulched pineapple fields.

Immigrant. Widespread over northern United States and Europe.

Type in the U.S. National Museum.

Distinguished from other American *Anarete* by having the wings pale white, the claws acuminately pointed, apical segment of palpus not enlarged, male basistylus lacking a setulose swelling on inner side distally, and basitarsus of male one-half as long as tibia. The species is scatopsid-like in appearance but is distinguished by the wing venation and details of body structure, palpi, and antennae. The male antennae are 9-segmented and those of the female are 11-segmented, with the last two very closely joined or fused; the pedicel of the male is greatly enlarged (fig. 81a). There is considerable variation in the amount of fusion of the last two segments of the antenna; in some specimens the two are completely fused, the apical segment being identified only by the whorl of setae present, in others they are quite distinct. The first segment of the palpus has a dense clump of sensory setae on the inner surface (fig. 81b). The compound eyes are separated on the front by a space equal to the width of six to eight eye facets.

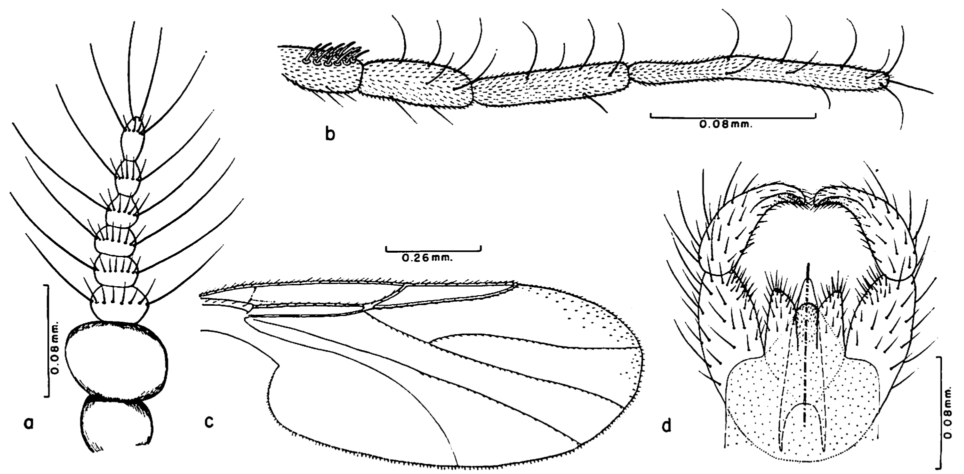

Figure 81—*Anarete johnsoni* (Felt): **a,** male antenna; **b,** palpus; **c,** wing; **d,** male genitalia, dorsal view.

The legs are fuscous yellow, the tarsi are slightly darker than remainder of the legs; the empodium is longer than the claws. The wings are as in figure 81c. The subcosta is not developed and the radial veins are thickened and more darkly pigmented than the other veins. R_{4+5} ends in the costa at about the apical three-fourths of the wing, and the thickening of the wing margin is rather indistinct beyond this point. The r–m crossvein is very short and M_{1+2} is about one-third as

long as M_2. M_{3+4} and Cu_1 are present; Cu_2 is lacking. Male genitalia as in figure 81d; basal extensions of aedeagus slender and rather elongate, extending as far as the base of the penis.

Length: body, 1.7–2.5 mm.; wings, 1.5–1.8 mm.

Genus **LESTREMIA** Macquart

Lestremia Macquart, 1826, Insect. Dipt. Nord. France, Part I, Tipul., p. 173.
Lestremia (*Cecidogona*) Loew, 1844, Ent. Zeits. Ent. Ver. Stettin 5:324.
Cecidogona Loew, Walker, 1856, Ins. Brit. Mus. Dipt. 3:53.

The members of this genus are characterized by having 16 segments in the antennae; the flagellar segments have moderately long stems and each has two well-developed crenulate whorls (in male); in the female the flagellar setments are slender, parallel-sided, attenuated at apices but not as long-stemmed as in male. The genus fits close to *Anaretella* Enderlein, but in *Lestremia* the flagellar segments have only sensory spines in both sexes (no digitate sensory processes are present) and vein M_{3+4} arises proximally before level of r–m crossvein rather than beyond. Also the tegmen (the surrounding sheath of aedeagus) is very narrow on the apical portion and the root of each basistylus is directed inwardly (fig. 84c); in *Anaretella*, the tegmen is broad, with the root of the basistylus directed anteriorly.

Type of genus: *Lestremia cinerea* Macquart.

Key to Species of Lestremia Known from Hawaii

1. Each dististylus with two teeth at apex (terminating in two sharp points). Genitalia as in figure 82c; dorsal plate with rather sharp-pointed lobes which extend approximately as far as the apices of the basistyli. Female with stem of third flagellar segment broader than long (fig. 82a) .... **cinerea** Macquart.

   Each dististylus ending in a single spine. Dorsal plate with lobes rounded and extending well beyond apices of basistyli (fig. 83a). Female with stem of third flagellar segment distinctly longer than wide 2

2. Aedeagus broad, the attenuated portion rather short. Ninth tergum gently convex or straight on hind margin (fig. 85d). Stems of flagellar segments of males at least as long as the nodes and four or more times longer than wide; stems longer than wide in females. Larger species, wings 2.75–4.0 mm.; found in the mountains 3

   Aedeagus long and slender, the attenuated portion longer than the thickened basal portion. Hind margin of ninth

tergum subacutely pointed (fig. 84c). Stems of flagellar segments shorter than nodes, that of the fifth segment about three times longer than wide in males and as wide as long in females. Smaller species, wing, 2.0 mm.; common in the lowlands.................... **leucophaea** (Meigen).

3. Hind margin of ninth tergum straight. Each dististylus with a large spine at apex. Cerci with rather strong erect setae (fig. 83a). Stem of fifth antennal segment about four times longer than wide. Hawaii............ **clivicola** n. sp.

Hind margin of ninth tergum gently convex. Each dististylus with a small spine at apex. Cerci densely setulose but lacking the strong setae (fig. 85d). Stem of fifth antennal segment about six times longer than wide. Maui........ .... **palikuensis** n. sp.

Lestremia cinerea Macquart (figs. 82a–c).

Lestremia cinerea Macquart, 1826, Insect. Dipt. Nord. France, Part I, Tipul., p. 173.
Lestremia fusca Meigen, 1830, Syst. Beschr. Bekann. Eur. Zweifl. Insekt. 6:309.
Lestremia ?fusca Meigen, Winnertz, 1870, Verh. Zool.-Bot. Ges. Wien 20:33.
Catocha sylvestris Felt, 1907, Bul. N. Y. State Mus. 110:102.
Lestremia kansensis Felt, 1908, Bul. N. Y. State Mus. 124:311.
Lestremia franconiae Felt, 1908, Bul. N. Y. State Mus. 124:311.
Lestremia dyari Felt, 1908, Bul. N. Y. State Mus. 124:311.
Zygoneura fenestrata Malloch, 1914, Bul. Ill. State Lab. Nat. Hist. 10:233.
Lestremia floridana Felt, 1915, Canad. Ent. 47:226.
Lestremia garretti Felt, 1926, Canad. Ent. 58:265.

Oahu; also questionable records from Hawaii. Probably found in the lowlands on all of the islands. Determination of this species was confirmed by Dr. A. E. Pritchard, University of California.

Immigrant. Widespread over Europe and North America. Pritchard (1953:127) says specimens of this species are found principally in the shade of trees and on windows. In Hawaii it is very common at lights. Barnes has reared this species from larvae feeding in stalks of mushrooms. Nothing is known of its life history in Hawaii.

Location of type not known.

This species is readily recognized by the development of the male genitalia. The dististyli end in two points, the dorsal plate extends just beyond the apices of basistyli, and the lobes are rather acutely pointed on outer edge (fig. 82c). The ventral plate appears to be divided into a pair of rather slender, densely pubescent lobes extending on each side of the aedeagus. The aedeagus is rather broad (fig. 82b). The stems of the flagellar segments of the male are approximately three times longer than wide and about two-thirds as long as the node (using the

third flagellar segment). The stem of the third flagellar segment in the female is broader than long (fig. 82a); Pritchard (1951:245) points out that the lengths of the nodes and stems of the flagellar segments are variable in the females of this species but that, for the most part, the female can be recognized by the very short stems.

Length of wing, 2.0–2.5 mm.

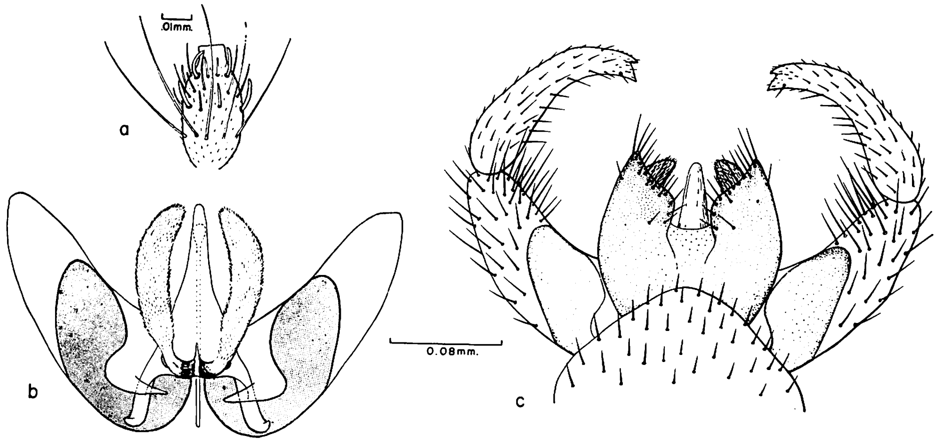

Figure 82—*Lestremia cinerea* Macquart: **a,** fifth antennal segment of female; **b,** ventral plate of male genitalia (dorsal plate removed); **c,** male genitalia, dorsal view.

Lestremia clivicola, new species (figs. 83a–d).

This species shows closest relationship to *L. palikuensis* n. sp. than to other known *Lestremia*; the two apparently are endemic to these Islands and seem to have arisen from an ancestral species, probably similar to *L. leucophaea* (Meigen). The main divergence from *leucophaea* has been in the development of the male aedeagus (fig. 83a). There are also other differences (but less marked) in the other genital structures and in the antennae. Also, both of these species are nearly twice as large as typical *leucophaea*. *L. clivicola* differs from *palikuensis* by having the sclerotized portion of the ninth tergum much more poorly developed and the hind margin straight; the clasper is much stouter, thicker at base, and with a much stronger spine at apex (fig. 83a); the cerci are distinctly bristled; and the stems of the flagellar segments are not so elongate (fig. 83c).

MALE. Predominantly pale brown. *Head:* Scape and pedicel yellow, remainder of antenna yellow-brown. Stems of flagellar segments about equal in length to the nodes and about four times longer than wide. Last antennal segment nearly three times longer than wide and with a short nipple developed at the apex. Palpi rather elongate and slender, last segment about one-third longer than penultimate; no distinct sensory structure present except for a depressed area filled with sensory setae on inner edge of first segment. *Thorax:* Brown on the dorsum,

yellow on the sides. *Legs:* Yellow-brown. All tarsal claws serrate (fig. 83d). *Wings:* Faintly fumose, venation as in figure 83b. *Abdomen:* Brown on the dorsum, yellow on the venter. Sclerotized portion of ninth tergum reduced to a rather narrow band along hind part of segment; this is three or more times broader than long and the posterior margin is straight. The cerci are broad and show no evidence of a median connection. The inner surface of each basistylus is deeply emarginate. The dististyli are short and broad and each has a large spine at apex. The aedeagus is also short and broad, attenuated only for a short distance at apex (fig. 83a).

Length: wing, 2.75–3.5 mm.

FEMALE. Colored like the male. The stems of the flagellar segments are approximately two times longer than wide and the nodes are about two and a half times longer than wide. The first segment of the palpus is densely covered with rather large flattened (not so scale-like as in *palikuensis*) sensory setae over the upper surface. Lobes of cerci oval.

Holotype male (on slide): Keanakolu, Hawaii, 5,200 ft., October, 1952 (D. E. Hardy). Allotype female (on slide): Hawaii National Park, Hawaii, June, 1953 (D. E. Hardy). Three paratypes (two on slides, one on paper point; two males, one female): north slope of Hualalai, Hawaii, July, 1953 (D. E. Hardy); Upper Olaa Forest Reserve, Hawaii, July, 1953 (D. E. Hardy); and 29 miles, Olaa, Hawaii, August, 1925 (W. M. Giffard).

Type and allotype in the B. P. Bishop Museum. Paratypes in the collections of the U.S. National Museum and the University of Hawaii.

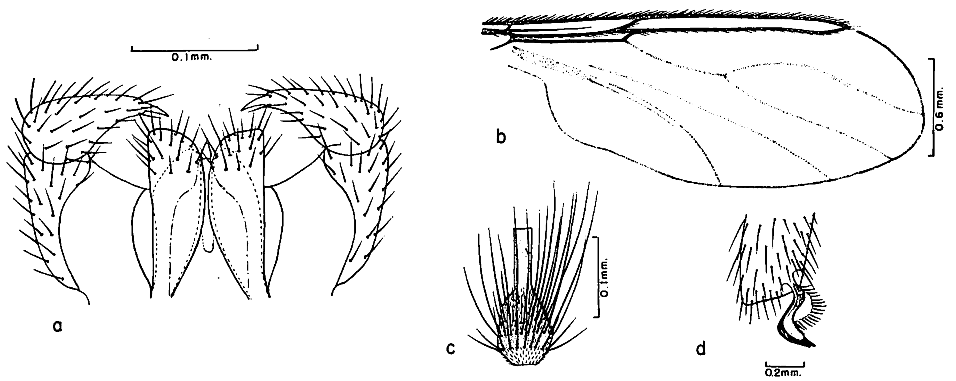

Figure 83—*Lestremia clivicola* n.sp.: **a,** male genitalia, dorsal view; **b,** wing; **c,** fifth antennal segment of male; **d,** tarsal claw.

Lestremia leucophaea (Meigen)(figs. 84a–c).

Sciara leucophaea Meigen, 1818, Syst. Beschr. Bekann. Eur. Zweifl. Insekt. 1:288.

Catocha sambuci Felt, 1907, Bul. N. Y. State Mus. 110:101.

Lestremia sambuci (Felt) Felt, 1908, Bul. N. Y. State Mus. 124:311.
Lestremia setosa Felt, 1908, Bul. N. Y. State Mus. 124:311.
Lestremia occidentalis Felt, 1926, Canad. Ent. 58:265.

Oahu; questionable records from island of Hawaii. Probably widespread over lowlands on all of the Islands. Common at lights on Oahu. Determination of this species was confirmed by Dr. A. E. Pritchard, University of California.

Immigrant. Europe, northern and western United States, and possibly also New Zealand and Australia; Edwards (1928:40) said "the species of *Lestremia* recorded from Australia and New Zealand belong to the typical subgenus and are similar to if not the same as *L. leucophaea Mg.*"

Type possibly in the Muséum National d'Histoire Naturelle, Paris.

A moderately small, predominantly brownish yellow species distinguished from other *Lestremia* by male genital characters as well as by the moderately elongate stems on the flagellar segments of both sexes. Also the wing venation has been used for separating this species; according to Edwards (1938:27), the distinctive character of the wing venation is that the lower branch of the median fork typically forms a straight line with M_{1+2} rather than vein M_2 being slightly arched near its base; this character seems somewhat variable and I find that I cannot rely upon it for separating the specimens which I have studied. In the males the stems of the flagellar segments are nearly as long as the nodes (fig. 84a); in the female the stem of the third flagellar segment is distinctly longer than wide (fig. 84b). The stems of flagellar segments beyond the middle of antennae are approximately two times longer than wide. Each male dististylus ends in a single spine. The lobes of the dorsal plate are broadly rounded at apices and extend well beyond the basistyli (about as far as apices of dististyli). The ventral plate is divided into two rather elongate hairy lobes extending along each side of the aedeagus. The aedeagus is elongate and very slender. According to Edwards (1938:27 and fig. 0, p. 26), the ninth tergum is broadly rounded at apex; the specimens from Hawaii have the ninth tergum distinctly pointed at apex (fig. 84c).

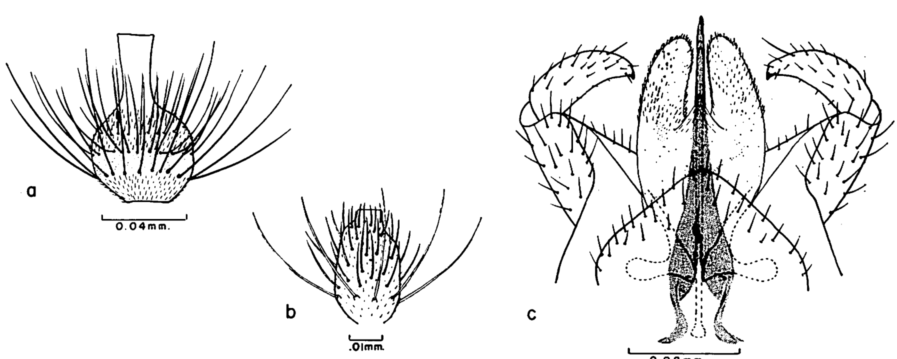

Figure 84—*Lestremia leucophaea* (Meigen): **a,** fifth antennal segment of male; **b,** fifth antennal segment of female; **c,** male genitalia, dorsal view.

This may represent a distinct species.
Length: wing, 1.8–2.5 mm.

Lestremia palikuensis, new species (figs. 85a–d).

Fitting much of the description of *L. clivicola* n. sp. and differing by the following details: the stems of the flagellar segments of the male are longer than the nodes and are about six times longer than wide (fig. 85a). The first palpal segment has no sunken area on inner surface but has a clump of rather long sensory setae at inner apical angle (fig. 85b). The ninth tergum is gently convex on the hind margin. The claspers are not as thickened basally, and the apical spine is small (fig. 85d); also, the cerci are densely setose but without distinct bristle-like setae. The first segment of the female palpus is densely covered with flattened, scale-like sensory setae over the apical two-thirds of the upper surface (fig. 85c), and the stems of the flagellar segments of the female antennae are about three times longer than wide.

Length: wing, 3.0–4.0 mm.

Holotype male, allotype female, and 10 paratypes (4 males, 6 females): Paliku, Haleakala Crater, Maui, 6,300 ft., June 1953 (D. E. Hardy). The type, allotype, and two paratypes are mounted on slides; four paratypes are mounted on paper points, and the others are in alcohol.

Type and allotype in the B. P. Bishop Museum. Paratypes in the collections of the U.S. National Museum and the University of Hawaii.

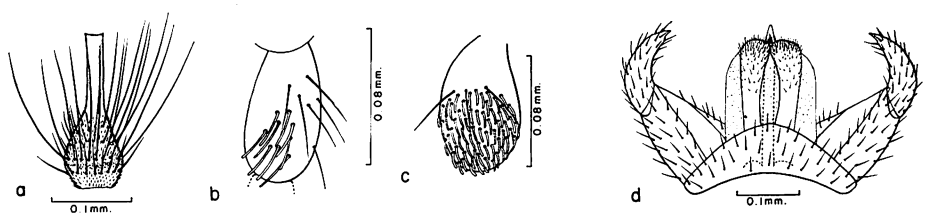

Figure 85—*Lestremia palikuensis* n.sp.: **a,** fifth antennal segment of male; **b,** basal segment of male palpus; **c,** basal segment of female palpus; **d,** male genitalia, dorsal view.

Tribe MICROMYINI Rondani

Micromina Rondani, 1856, Dipt. Ital. Prod. 1:41.
Micromyna Rondani, 1856, Dipt. Ital. Prod. 1:198.
Campylomyzides Kieffer, 1898, Bul. Soc. Hist. Nat. Metz 8(Ser. 2):48.
Campylomyzariae Kieffer, 1900, Ann. Soc. Ent. France 69:451.
Termitomastidae Silvestri, 1901, Boll. Mus. Zool. Anat. Comp. Univ. Torino 16:1.
Termitomastinae Silvestri, Speiser, 1906, Zool. Anz. 30:716.
Campylomyzini Enderlein, 1911, Arch. Naturg. 77:195.
Campylomyzinae Enderlein, 1912, Zool. Anz. 40:262.

Campylomyzidae Enderlein, 1936, Tierw. Mitteleur. 6:60.
Micromyini Rondani, Pritchard, 1947, Ento. Amer. 27(New Series):9.

The members of this tribe are differentiated from other Lestremiinae by having three ocelli, vein M_{1+2} simple, M_{3+4} and anal veins lacking, vein Cu forked, and female with sclerotized spermathecae. In some other areas of the world, apparently, apterous and brachypterous species occur; these are differentiated by the three ocelli and by the sclerotized spermathecae of the female. The Hawaiian species are also characterized by having the eyes deeply emarginate on sides of head and nearly divided into three groups joined by a narrow bridge of facets (one or two wide) on each side (fig. 87d); also, in one of our species the palpi have three segments and only two in the other, rather than the four normal for the tribe.

There are two known genera from Hawaii (*Monardia* Kieffer and *Mycophila* Felt), plus one species which seems to fit between these two genera.

For a revision of the North American Micromyini, see Pritchard (1947); also refer to Edwards (1938) for a monograph of the British species with notes on exotic species.

Genus **MONARDIA** Kieffer

Monardia Kieffer, 1895, Misc. Ent. 3:111.
Pezomyia Kieffer, 1913, Bul. Soc. Hist. Nat. Afr. Nord. 4:92.

The members of this genus are characterized by having 14 segments in the antennae, the flagellar segments with moderately long stems, and the eye bridge not over four to five facets wide (two in the Hawaiian species). Also, the females have two spermathecae; the flagellar segments have disc-like sensory processes. The Hawaiian species can also be differentiated by the three-segmented palpi, by the rudimentary empodium (the empodium is evidently well developed in two

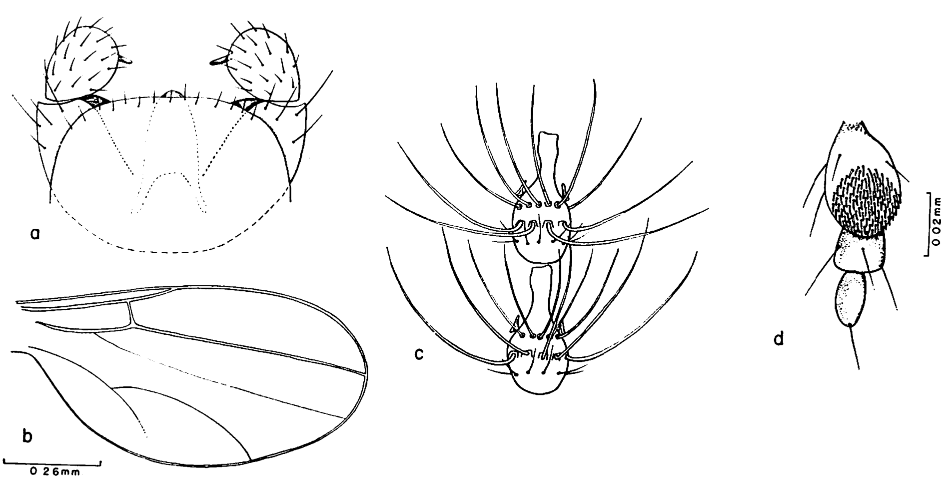

Figure 86—*Monardia recondita* n.sp.: **a,** male genitalia, dorsal view; **b,** wing; **c,** fifth and sixth flagellar segments of antenna; **d,** palpus.

European species), by the broad rounded dististyli of the male, by the presence of a genital rod (fig. 86a), and by the short vein Cu_2 (fig. 86b).

There is little information concerning the habits of species of this genus. Some have been reared from dead wood and some from fungus [infested] wood; they may be fungus feeders. Barnes has suggested that *vanderwulpi* (a synonym of *stirpium*) may reproduce by paedogenesis.

One species is known from Hawaii.

Type of genus: *Monardia stirpium* Kieffer.

Monardia recondita, new species (figs. 86a–d).

This appears to be related to *M. ulmaria* Edwards (described from England) by having just three segments in the palpus and each dististylus with an apical tooth. It differs by having each dististylus much shorter, more rounded, with a small, rather inconspicuous, apical tooth (fig. 86a); the ninth tergum is over half as long as the basistyli, not about one-third as long; vein Cu_2 does not extend to the wing margin (fig. 86b); the sensory structures on the antennae are very different (fig. 86c); and the specimens are much smaller, the wing measuring 1.1 mm. rather than 2.0 mm.

MALE. Tiny, dark-colored. *Head:* Palpi three-segmented, the first rather large and thickened, about one-third longer than the short second and third segments combined (fig. 86d). Antennae 14-segmented, each flagellar segment with the stem slightly shorter than the node and each node with two rings of long setae and with small, mushroom-like sensory structures (fig. 86c). The last two segments are oval and have no stems. The eyes are narrowed to two rows of eye facets on each side of the head. *Legs:* Short and stout; the basitarsi are about equal in length to the next three tarsal segments. Claws simple, just slightly curved; empodium rudimentary. *Thorax:* Predominantly brown. *Wings:* Hyaline; Rs well developed and two-thirds as long as R_1; Cu forked; Cu_2 short, evanescing before the wing margin (fig. 86b). Male genitalia as in figure 86a. Dististyli not much longer than wide and each with a small spine at apex.

Length: wing, 1.1 mm.

FEMALE. Unknown.

Holotype male: Ewa, Oahu, at light, November, 1955 (J. W. Beardsley). Two paratype males: Kalihi, Oahu, in damp moss, May 14, 1952 (A. Suehiro); Keaau Orchard, 3 miles, North Olaa, Hawaii, September, 1956, light trap.

Type in Hawaiian Sugar Planters' Association collection. One paratype in B. P. Bishop Museum and one in University of Hawaii collection.

Genus **MYCOPHILA** Felt

Mycophila Felt, 1911, Jour. N. Y. Ent. Soc. 19:33.

This genus is characterized by having only 8 to 10 short-stemmed flagellar segments in the male antennae (9 in the Hawaiian species), the female with 9 to 11 antennal segments (9 in Hawaiian species) and each flagellar segment of both sexes with a pair of broad lobed, or digitate sensorial processes (fig. 87e). Also

the female with a single spermatheca; the male diststylus with an apical spine and the genital rod absent. The Hawaiian species can be recognized by the two-segmented palpus.

Apparently only five species are known throughout the world: one from California, one from Minnesota and Wisconsin, one from India, and two from England. Evidently all are mushroom feeders; three have been reared from mushrooms. Barnes has shown that paedogenesis occurs in *M. speyeri* Barnes, and it is probable that other species reproduce in this manner. One species is known from Hawaii.

Type of genus: *Mycophila fungicola* Felt.

Nayar's key to the species (1949:81) is misleading; it works only for females. He keys out *M. fungicola* Felt as having 9 segments in the antennae. According to Pritchard (1947:65) and from specimens compared with the type, the male has 11 segments in the antennae and the female has 9 segments, with the terminal segment compound but incompletely divided in both sexes. Nayar also keys *speyeri* Barnes as having 10 segments, but the male has 11. *M. barnesi* Edwards is apparently the only known species with 11 segments in both sexes. *M. lampra* Pritchard has 10 in each sex and would key out with *M. indica* Nayar in Nayar's key. It would be difficult to differentiate since the latter is known only from the females. *M. speyeri* Barnes and *fungicola* Felt are the only known species which have just two segments in the palpi.

Tentative Key to Known Species of Mycophila for the World

1. Palpi two-segmented 2
   Palpi three-segmented 3

2. Empodium rudimentary; ninth tergum of male narrow; England . . . . **speyeri** Barnes.
   Empodium one-half as long as claws; ninth tergum broad, as long as wide; California and Hawaii . . . . **fungicola** Felt.

3. Antennae of both sexes 11-segmented, ninth tergum of male very short, four to five times wider than long (Edwards 1938:253, fig. E); England . . . . **barnesi** Edwards.
   Antennae 10-segmented, at least in female (male of *indica* not known) 4

4. Claws gently curved; two sensorial processes on each flagellar segment of female; north-central United States. . . . . **lampra** Pritchard.
   Claws curved at right angles; numerous stemmed disk-like sensoria on female flagellar segments; India. . **indica** Nayar.

Mycophila fungicola Felt (figs. 87a–f).

Mycophila fungicola Felt, 1911, Jour. N. Y. Ent. Soc. 19:33.

Oahu (Known only from light-trap catches at Ewa).

Immigrant. Previously known only from the type male and allotype female reared from mushrooms collected by H. C. Evans at San Rafael, California, September 7, 1897.

Type in the U.S. National Museum. The Hawaiian specimens have been compared with the type by Dr. R. H. Foote.

Host: Mushrooms.

This species has been poorly known. The original specimens are in poor condition and the characteristics of the palpi and the genitalia have never been described. The species is obviously very close to *M. speyeri* Barnes from England because of the two-segmented palpi. I have seen only the female of the latter species and it has 10 segments in the antennae and the empodium is rudimentary. The female of *fungicola* has 9 to 11 segments in the antennae and the empodium is about one-half as long as the claws. Edwards (1938:254) says the male genitalia of *speyeri* are "much as in *barnesi*" and he shows a very narrow ninth tergum in his figure of *barnesi*. The ninth tergum of *fungicola* is broad (fig. 87a).

M. fungicola ia a very tiny species, the smallest known in the Hawaiian fauna. It is predominantly yellow-red, tinged with brown on mesonotum. Eyes are nearly divided into three parts, looking superficially like *Trisopsis* Kieffer or *Triommata* Barnes but having a very narrow bridge of eye facets joining the eye masses at the sides of the head (fig. 87d). Palpi are two-segmented and with a

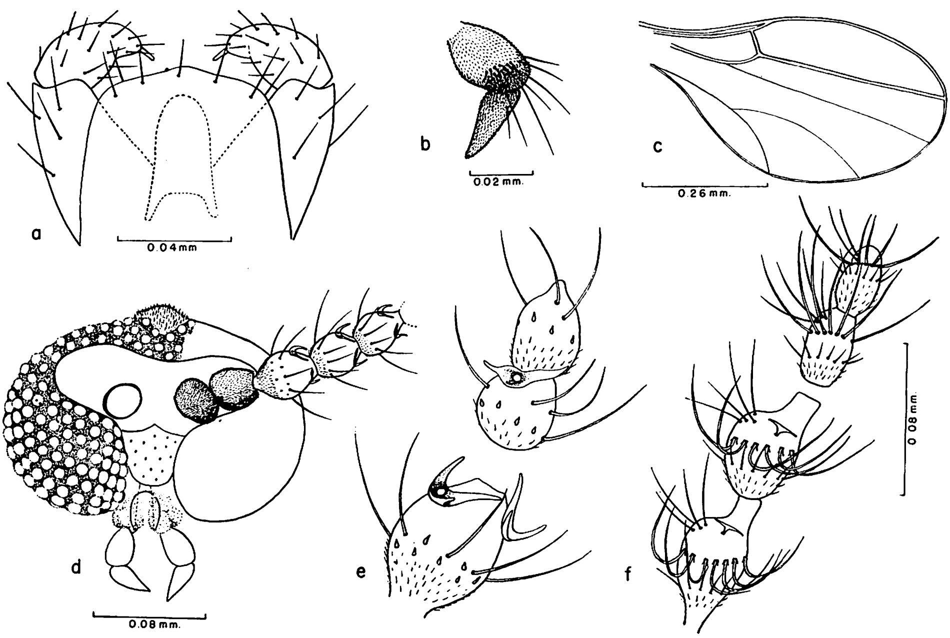

Figure 87—*Mycophila fungicola* Felt: **a,** male genitalia, dorsal view; **b,** palpus; **c,** wing; **d,** head of female; **e,** basal flagellar and apical antennal segments of female; **f,** basal flagellar and apical segments of male.

patch of sensory setae on first segment (fig. 87b). Male antennae are 11-segmented with short stems and two mushroom-like sensory structures near distal end of each segment (fig. 87f). Female antennae are 9-segmented; they are sessile and the sensory structures are tridigitate (fig. 87e). The empodium is about half as long as the claws (Felt was in error saying it was rudimentary). The wings are hyaline. Vein R_1 is slightly shorter than Rs and ends in costa well before middle of wing. Vein R_{4+5} is straight, entering the costa at or slightly before apex. Vein M_{1+2} is present and Cu is forked with Cu_2 extending to wing margin (fig. 78c). Male genitalia are as in figure 87a. Each diststyli has an apical tooth; there is no genital rod and the ninth tergum is as long as wide. The female has one sclerotized spermatheca.

Length: body and wings, 0.6 mm.

Subfamily Cecidomyiinae Rondani

Cecidominae Rondani, 1840, Sopra Alc. Gen. Inset. Ditt., Mem. Sec. Serv. Ditt. Ital., Parma, p. 6.
Cecidomynae Rondani, 1856, Dipt. Ital. 1:41.
Cecidomyinae Schiner, 1864, Fauna Austr. Die Fliegen 2:XIX.
Cecidomyina Skuse, 1889, Proc. Linn. Soc. N. S. Wales, 2nd Ser. 3(1):47.
Cecidomyiinae Kertesz, 1902, Cat. Dipt. 2:14.
Itonididinae Felt, 1915, Bul. N. Y. State Mus. 175:79.
Itonidinae Pritchard, 1953, Bul. Calif. Ins. Sur. 2(2):125. Rao (1955:223) attributed the subfamily Itonidinae to Hendel (1908:49); this is an error. Hendel merely used the genus name *Itonida* for the first time since Meigen, 1800.
Heteropezinae, in part, of many authors. See discussion in introduction.

For more complete synonymy see Handlirsch, in Schröder (1925:957–958).

Distinguished from members of other subfamilies by the very short metatarsi of all legs, plus the reduced wing venation (vein M simple or lacking). The antennae are differently developed, usually with circumfila on the flagellar segments of the male and with the flagellar segments typically binodose and with three circumfila; only two circumfila are developed in species of the tribe Contariniini; we have but one species of *Johnsonomyia* Felt (Tribe Epidoseini) which apparently lacks circumfila.

This is a very large group. Four tribes occur in Hawaii. According to Pritchard (1953:132), the subfamily contains over 400 genera. He says, "The more generalized members are saprophitic and certain of the more specialized species are fungivorous. Some species are predaceous or even parasitic on mites or insects. However, most of the species feed on higher, living plants and often produce characteristic galls. A few are inquilines in these galls or the galls of other insects."

According to Pritchard (1953:125), the larvae may be distinguished from those of other subfamilies by the anus, which is longitudinal and located on the venter of the last segment.

Key to Tribes and Genera and some Species of Cecidomyiinae Based upon Males

1. Flagellar segments binodose 6
   Each flagellar segment with only a proximal node and distal stem (fig. 88c) 2

2(1). Tarsi with only two segments (fig. 89d). Mouthparts rudimentary, palpi lacking . . . . **Oligarces** Meinert.
   Segmentation of tarsi not reduced. Mouthparts normal, palpi present 3

3(2). Vein Cu simple. Wings very densely scaled (fig. 88b), venation obscured. Circumfila of antenna as in figure 88c. Palpus 3-segmented. Tribe **Brachyneurini** . . . . **Brachyneura eupatorii** Felt?
   Cu forked. Wings scaled only in *Phaenolauthia* (fig. 95c). Circumfila and palpi not as above. Tribe **Oligotrophini** 4

4(3). Wings scaled, densely so on costal margin (fig. 95c). Antennae 14-segmented. Front claws toothed, mid and hind claws simple . . . . . . **Phaenolauthia** Kieffer.
   Wing devoid of scales. Antennae and claws not as above 5

5(4). Antennae 12-segmented. Palpus 4-segmented. Claws all simple . . . . **Mayetiola** Kieffer.
   Antennae 17–18-segmented. Palpus 2-segmented. All claws toothed . . . . **Diarthronomyia chrysanthemi** Ahlberg.

6(1). Rs well developed, appearing as a crossvein continuous with base of vein R_{4+5} (fig. 96b), or oblique in position. Tribe **Epidoseini** 7
   Rs absent or weakly developed (if partially developed it is very short and vertical to R_{4+5}) (fig. 97e) 8

7(6). Rs at an oblique angle to R_{4+5}. Cubital vein simple. Dark-colored species . . . . **Johnsonomyia** Kieffer.
   Rs continuous with R_{4+5}. Cu forked. Predominantly white species . . . . **Porricondyla** Rondani.

8(6). Nodes of flagellate antennal segments equal; only two circumfila on each segment (fig. 92a). Tribe **Contariniini** 9
   Nodes of flagellate antennal segments unequal; three circumfila on each segment (fig. 98a). Tribe **Cecidomyiini** 10

9(8). Basistyli lacking basal lobes (fig. 91e) . . . . **Contarinia** Rondani.

Each basistylus with a strong spine-like subbasal lobe on inner margin (fig. 92c) .... Genus? (related to **Procontarinia** Kieffer and Cecconi).

10(8). Eyes normal, not divided into three parts 11
Eyes divided into three parts (fig. 107b) .... **Trisopsis oleae** Kieffer.

11(10). Claws toothed on all tarsi. Genitalia with a pair of spine-like lobes present on each side of aedeagus (fig. 99c), or with the dististyli pectinate at apices (fig. 98h) 12
At least hind claws simple. Genitalia not as above 13

12(11). A pair of spine-like lobes on each side of aedeagus; dististyli slender (fig. 99c) .... **Dicrodiplosis guatemalensis** Felt.
Lacking such lobes; dististyli short and broad, pectinate at apices (fig. 98h) .... **Coccodiplosis ananasae** n. sp.

13(11). Front and sometimes middle claws toothed 14
All claws simple 15

14(13). Circumfila each with one or more greatly produced bows or loops having a length 5–10 times that of the node and extending approximately at right angles to it (fig. 106a). Ventral plate not lobed, strongly enlarged at apex. Claspers simple. Basistylus not lobed (fig. 106c) .... **Phaenobremia meridionalis** Felt.
Circumfila not greatly produced (fig. 102b). Genitalia very different, with a strong apical lobe on basistylus (fig. 102d) .... **Lobodiplosis pseudococci** Felt.

15(13). Wings with two prominent black spots on anterior margin (fig. 105a). Genitalia as in figure 105b .... **Parallelodiplosis bimaculata,** n. sp.
Wings not as above (if spotted, the spots are generally distributed over the wing surface) 16

16(15). Vein R_{4+5} ending distinctly before the wing apex (fig. 103a). Claspers short, rather broad (figs. 97f and 103b) 17
Vein R_{4+5} curved at least slightly downward ending below or at the wing apex. Claspers slender 18

17(16). Vein R_{4+5} curved upward so that cell R_1 is narrowed and pointed at apex (fig. 103a). Stems of flagellar segments comparatively long, three to four times longer than wide (fig. 103c). Basistyli not lobed, ventral plate concave at apex (fig. 103b) .... **Microdiplosis beardsleyi,** n. sp.

Vein R_{4+5} straight, apex of cell R_1 not narrowed and pointed. Each basistylus with a broad rounded lobe at base. Stems of flagellar segments short, not over two times longer than wide (fig. 97a). Ventral plate rounded at apex, spatulate in shape (fig. 97f). A predator on mealybugs.. **Arthrocnodax walkeriana** Felt.

18(16). Each basistylus with a setulose lobe at base; ventral plate not concave at apex (fig. 101h)..**Lestodiplosis** Kieffer.

Basistyli without basal lobes; ventral plate concave at apex.....................................19

19(18). Wings spotted (fig. 104a). Ventral plate extending just a short distance beyond dorsal plate (fig. 104c). Claws gently curved. **Nanodiplosis pucciniacola,** n. sp.

Wings not spotted. Ventral plate extending well beyond dorsal. Claws strongly bent at right angles (fig. 105f).....................................20

20(19). Ventral plate rather broad, gradually tapered apically, extending as far as apices of basistyli. Claspers pointed apically (fig. 105e). Gall-formers on roots of orchids (not known to be established)........................ **Parallelodiplosis cattleyae** (Molliard).

Ventral plate rather slender and elongated, slightly enlarged at apex and extending two-thirds as far as claspers. Claspers rounded apically (fig. 100f)....................................**Giardomyia** Felt.

Key to Genera and Species of Cecidomyiinae Based upon the Known Females

1. Ovipositor elongate, at least as long as the abdomen (fig. 91d).....................................2

Ovipositor short, not conspicuously protruded..........4

2(1). Ovipositor very elongate, needle-like (fig. 91d), longer than body. Palpi 4-segmented; antennae 14-segmented. Claws simple. **Contarinia** Rondani..........3

Ovipositor about as long as abdomen (when fully extended) but not so slender (fig. 93d). Palpi 2-segmented; antennae 15-segmented. Claws with a proximal tooth. . **Diarthronomyia chrysanthemi** Ahlberg.

3(2). Wings spotted (fig. 90d). Claws small, less than one-fourth as long as last tarsal segment. Stem of fifth segment one-half longer than wide; beyond middle,

the segments are two or more times longer than wide. Flagellar segments without circumfila but thickly covered with curled hairs (fig. 90c). **maculipennis** Felt.

Wings hyaline. Claws long and slender, half as long as last tarsal segment. Stems of flagellar segments wider than long and each with two raised thread-like circumfila girdling the segment (fig. 91c) . . . . **sorghicola** (Coquillett).

4(1). Tarsi 2-segmented (fig. 89d). Mouthparts rudimentary, palpi lacking . . . . **Oligarces** Meinert.

Segmentation of tarsi not reduced. Mouthparts normal . . . 5

5(4). Body and wings scaled 6

Wings devoid of scales 7

6(5). Vein Cu simple (fig. 88b). Circumfila of antenna as in figure 88c. Palpus 3-segmented . . . . **Brachyneura eupatorii** Felt?

Cu forked (fig. 95c). Circumfila as in figure 95a. Palpus 2-segmented in the known Hawaiian species . . . . **Phaenolauthia** Kieffer.

7(5). Radial sector rudimentary or absent (fig. 101g) or with a very short vertically placed Rs in *Giardomyia* (fig. 100a) 8

Radial sector well-developed, oblique or longitudinal in position (fig. 96b) 9

8(7). Vein R_{4+5} ending distinctly before the wing apex (fig. 103a) 10

R_{4+5} ending at or beyond apex of wing (figs. 100a and 101g) 11

9(7). All-white species. Radial sector parallel with R_{4+5} and Cu forked (fig. 96b) . . . . **Porricondyla** Rondani.

Dark-colored species. Rs at an oblique angle to R_{4+5}. Cu simple . . . . **Johnsonomyia** Felt?

10(8). Vein R_{4+5} curved upward so that cell R_1 is narrow, sharp pointed at apex (fig. 103a). Antennae 13-segmented and as in figures 103d–e . . . . **Microdiplosis beardsleyi,** n. sp.

R_{4+5} straight, cell R_1 not narrowed or pointed at apex (fig. 97e). Antennae 14-segmented and as in figure 97c . . . . **Arthrocnodax walkeriana** Felt.

11(8). Wings distinctly spotted 12

Wings not spotted 14

12(11). Wings with numerous, rather irregular scattered spots (fig. 101g) 13

Wings with two prominent brown to black marks along

the anterior margin, remainder of wing hyaline (fig. 105a) .... **Parallelodiplosis bimaculata,** n. sp.

13(12). Legs and flagellar segments of antennae pale colored, with brown to black bands .... **Lestodiplosis obtusilobata,** n. sp.

Legs and antennae not banded .... **Nanodiplosis pucciniacola,** n. sp.

14(11). Thorax all yellow except for dark brown scutellum and halteres. Abdomen and legs brown .... **Giardomyia pallidithorax,** n. sp.

Body not colored as above 15

15(14). Eyes divided into three groups of facets (fig. 107b) ... . **Trisopsis oleae** Kieffer.

Eyes not divided 16

16(15). Claws bent sharply at right angles .... **Giardomyia furvescens,** n. sp.

Claws not sharply curved 17

17(16). Claws toothed on all legs .... **Dicrodiplosis guatemalensis** Felt.

At least hind claws simple, usually all are simple 18

18(17). Stems of flagellar segments long and slender, three-fourths as long as the nodes (fig. 101e). Apical segment not produced at tip. All tarsal claws simple ... . **Lestodiplosis fimicola,** n. sp.

Stems very short, about one-fourth as long as nodes. Apex of last segment attenuated (fig. 102c). Anterior claws toothed 19

19(18). Vein R_{4+5} straight, ending at wing apex (fig. 102a) .... **Lobodiplosis pseudococci** Felt.

R_{4+5} strongly curved downward, ending well below the apex (fig. 106b) ..... **Phaenobremia meridionalis** Felt.

Tribe BRACHYNEURINI Kieffer

Brachyneurariae Kieffer, 1913, Gen. Ins. 152:101.
Heteropezinae Felt, in part, 1913, N. Y. State Mus. Bul. 165:202; 1925, *op. cit.* 257:138. *Nec.* Schiner, 1868, Riese der K. Fregatte Novara, Dipt. p. 5.
Brachyneurine Edwards, 1937, Ent. Month. Mag., 3rd ser., 73:149.

The members of this tribe apparently differ from other Cecidomyiinae by having just one node in each flagellar segment in combination with a lack of looped circumfila and very reduced wing venation (figs. 88b and 89e). The group has not been well defined in the literature and needs to be thoroughly studied in order to clarify its status. In the two genera recorded from Hawaii, known

only from females, one (*Brachyneura* Rondani) has long sinuous thread-like sensory structures extending longitudinally over each flagellar segment (fig. 88c) and the other (*Oligarces* Meinert) has peculiar scale-like sensory structures (fig. 89b). These two are readily separated from all other cecidomyiids known from Hawaii by the distinctive generic characters described below. I am placing *Oligarces* under Brachyneurini for want of a better place to put it. I am not sure that it properly belongs here.

Genus **BRACHYNEURA** Rondani

Brachineura Rondani, 1840, Mem. per serv. alla. Ditt. Ital., p. 18.
Brachyneura Agassiz, 1846, Nom. Zool. (Dipt.), p. 5 (emendation of "*Brachineura*" Rondani).
Brachynevra Agassiz, 1846, Nom. Zool. Index Univ., p. 51.
Spaniocera Winnertz, 1853, Linn. Ent. Stettin 8:190. Synonymy from Felt (1913:219 and 1925:139). Kieffer (1913:114) considered it a distinct genus.
Acroectasis Rübsaamen, 1910, Z. Wiss. Insekt. Biol. 6:131.
Brachyneurella Kieffer, 1913, Bul. Soc. Hist. Nat. Metz, p. 28.
The latter two synonyms from Edwards, 1937, Ent. Mo. Mag. 73:146.

Edwards (1937:146–147) said "The genus *Spaniocera* Winn. was first placed as a synonym of *Brachyneura* Rondani by Rondani himself in 1860, and this course has been followed by Rübsaamen, Felt, and other writers on this family of insects, though not by Kieffer. It will probably be best to follow Felt in accepting Rondani's decision, even though the original descriptions do not suggest that the two genera are identical; as the types of *Brachyneura* do not exist, Rondani's statement regarding the synonym cannot be disproved."

In the original description of *Brachyneura* (based upon *fuscogrisea* Rondani) Rondani (1840:18) described the antennae as 14–15-segmented in the male and 11-segmented in the female. In 1846 Rondani corrected some errors made in his earlier paper and stated that the antennae were 14-segmented in both sexes. Edwards (1937:147) said "In no place does Rondani mention the coating of scales which is a striking feature of *Spaniocera*." Winnertz (1853:190, 306) described *Spaniocera* (based upon *squamigera* Winnertz) as having the antennae 13-segmented in both sexes, the palpi 4-segmented, and the body and wings almost entirely covered with scales. Edwards (1937:147) mounted and examined the type of *S. squamigera* and found the antennae to be 12-segmented in both sexes (not 13). The species present in Hawaii would fit the concept of *Spaniocera* as modified by Edwards, except that the palpi are 3-segmented (not 4).

The Hawaiian representative of *Brachyneura* is readily differentiated from other known cecidomyiids in our fauna by the densely scaled body and wings in combination with the simple, not binodose, flagellar segments of the antenna. Also, it has just two longitudinal veins in the wings, the cubital vein is not forked, and there are only three segments in the palpi (fig. 88a).

In Felt (1925:139) this genus is placed in the subfamily Heteropezinae and fits near *Kronomyia* Felt, differing by having only two to three simple longitudinal

veins in the wing and the palpi 3-segmented rather than four longitudinal veins and the palpi 2-segmented. Edwards (1937:149) said "the correct systematic position of the genus, as remarked by Rübsaamen, is open to question; it certainly belongs to one of the higher tribes of Cecidomyiinae and not to the Heteropezinae; the antennal structures most resemble those of the Asphondyliariae [the densely scaled wings resemble those of *Lasioptera* Meigen (Lasiopterini)], but other structures (such as the genitalia of both sexes) do not confirm the suggestion of affinity with that group. I therefore retain for the present Kieffer's tribe Brachyneurini (Brachyneurariae)." The present-day students of this group apparently agree with Edwards' concept.

Edwards also gave the following details which characterize the genus. They are based on *Spaniocera squamigera* Winnertz, however, and not on *Brachyneura fuscogrisea* Rondani. The flagellar segments of the antennae are cylindrical, with circumfila present in the male "(though difficult to trace except in a denuded and stained mount) in the form of sinuous threads running the whole length of the segment; they have transverse connexions at each end of the segment, but few or none intermediately. Only an apical circumfilum in the female antenna can be made out in the specimens examined. On the front legs the claws are rather large and strongly bifid; on the middle and hind legs they are simple." The empodium is small, about half as long as the claw in the male of *squamigera*. The dorsal and ventral plates of the male genitalia are rather deeply cleft in middle of hind margin and the diststyli are simple.

The record of this genus in Hawaii is based on one female specimen which was determined as *Brachyneura* sp.? by Dr. A. E. Pritchard who remarked (in correspondence) "It is true that your female differs from his [Dr. Edwards'] generic diagnosis in that claws II are dentate and that the proximal flagellar segments have distal setae [Edwards said the flagellar segments "are entirely devoid of hairs even at the tip, all the hairs being replaced by small decumbent scales"], but I do not regard this of more than specific differentiation. Edwards apparently did not see the circumfila, but they are very distinctive on your specimen." On the female specimen at hand the circumfila consists of longitudinally arranged threads extending the entire length of the segment (fig. 88c), much as in Edwards' figures of males (1937:148 and 150) but the threads are not as sinuous.

Type of genus: *Brachyneura fuscogrisea* Rondani.

Brachyneura eupatorii Felt? (figs. 88a–c).

Brachyneura eupatorii Felt, 1908, Bul. N. Y. State Mus. 124:317.

Oahu.

Immigrant. Northeastern United States, probably more generally spread. Type locality, Poughkeepsie, N. Y.

Type in the U.S. National Museum.

Host plant: The type was reared "possibly from a gall on thoroughwort, *Eupatorium perfoliatum*. . . . The swelling on the stem was about 6 mm. in diameter and contained six yellow larvae occupying cocoons massed in the center of the cell."

One female specimen collected on vegetation on Mt. Tantalus, Oahu, September, 1953 (M. S. Adachi) seems to be this species. It has been compared with the type by Dr. R. H. Foote and he was unable to find any differentiating characters. The specimen was collected in an area where *Eupatorium glandulosum* H.B.K. grows abundantly, but the species has not been associated with a plant host in Hawaii.

This species is readily recognized by the characteristics given in the generic discussion above and as shown in figures 88a, b, and c. The dense covering of curled scales over the wings is especially characteristic. Three simple longitudinal veins are supposed to be present, but, because of the dense scale covering, only two, the radial and the medial, veins can be seen on the specimen at hand.

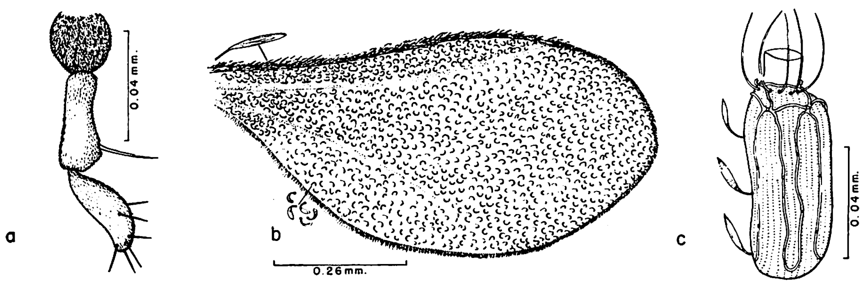

Figure 88—*Brachyneura* sp.? near *eupatorii* Felt: **a,** palpus; **b,** wing; **c,** fifth antennal segment.

Genus **OLIGARCES** Meinert

Oligarces Meinert, 1865, Naturhist. Tidsskr. ser. 3, III:238.

The members of this genus are characterized by having only two segments in each tarsus (fig. 89d) and also by the rudimentary mouthparts. The wings are finely haired, and only two poorly developed longitudinal veins are present (fig. 89e) in the species at hand.

It is probable that all of the species of *Oligarces* have a rather complex life cycle of both paedogenetic and normal generations. In the type of the genus, the large fertilized eggs laid by the female develop into paedogenetic larvae which may give rise to other paedogenetic larvae or to larvae which develop into adult males and females.

Type of the genus: *Oligarces paradoxus* Meinert.

Oligarces sp.? (figs. 89a–f).

Only one female specimen has been seen to date; this was collected walking across the desk in a laboratory at the University of Hawaii, November, 1957, by Mrs. M. Adachi Kohn. The species appears to fit close to *O. ulmi* Felt, described

from Nassau, New York, and apparently differs by having only 9 distinct segments in the antenna, not 10 to 12; and by having the fifth antennal segment globular and about as wide as long, not broadly pyriform and one-fourth longer than wide. I suspect that there are a number of structural details which would differentiate these two species but this information is not presented in Felt's description.

Head: Antenna pale colored with nine distinct segments, as stated above; the first flagellar is apparently composed of two fused segments and two rows of bristles are present. Each of the flagellar segments has a row of short, broad, pale-colored, spine-like bristles, some of which are bifid, near the apical portion (fig. 89b); also each segment has one or two black bristles located near the inner margin. All antennal segments are densely covered with microsetae (fig. 89a). Mouthparts are rudimentary, reduced to just a tiny oral opening with no labellum or mouthparts visible; palpi are absent. Eyes are protuberant, rather raspberry-like, made up of approximately 50 facets. The eyes are widely separated on the front; the distance between is almost equal to the length of the front. The front is brown, almost bare, with 9 to 10 small setae situated across the median portion. The face has three moderately strong bristles in middle just below antenna and with two bristles about half way between antennae and oral opening. Genae protuberant and transparent, appearing like a second pair of unfaceted eyes. *Thorax:* Predominantly brown with a Y-shaped pale mark on the mesonotum, the arms of the Y extending down each dorsocentral row (fig. 89c). The sides of the mesonotum are also pale colored. About 10 dorsocentral setae are present in

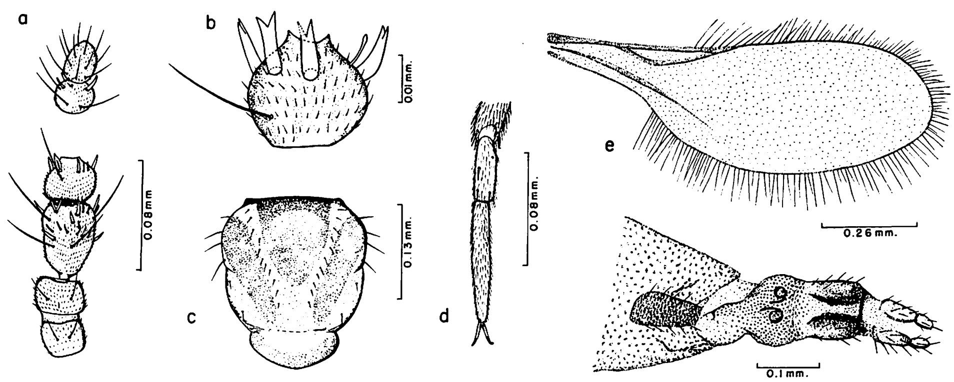

Figure 89—*Oligarces* sp.? near *ulmi* Felt: **a,** basal and apical segments of antenna; **b,** fifth antennal segment; **c,** mesonotum, dorsal view; **d,** hind tarsus; **e,** wing; **f,** female genitalia, ventral view.

each row. *Legs:* Pale colored, the first basitarsus just slightly shorter than the second segment, the proportions being 63:75. The middle and hind basitarsi are approximately half as long as the second segments (fig. 89d), the proportions being,

respectively, 43:80 and 38:75. Claws simple, pulvilli rudimentary. *Wings:* Rather narrow, three times longer than wide, with only two longtitudinal veins visible, both ending before the middle of the wing; the anterior vein is evidently the radius and the posterior vein is evidently the cubitus (fig. 89e). *Abdomen:* Brownish yellow, rather long and slender. Each tergum with about 10 small setae widely scattered over the median surface and each sternum with a row of 4 or 5 small setae extending down each side. Two spermathecae are present; ovipositor and apex of abdomen as in figure 89f. The egg-laying structure is not extended. The female abdomen contains four very large eggs, each occupying from two-thirds to three-fourths the length of the abdomen. These eggs probably would develop into paedogenetic larvae.

Length: Fully extended on a microscope slide, the body, including the ovipositor, measures 1.8 mm. *In situ*, it probably would measure 1.5 mm. Wings: 1.0 mm.

Tribe CONTARINIINI Enderlein

Contariniini Enderlein, 1936, Tierw. Mitteleur. 6(2), Insekten 3:71.
Bifili White, 1950, Univ. Texas Pub. 5007:8.
Bifilini Rao, 1955, Agra Univ. Jour. Res. (Sci.) 6(1):247.

Members of this tribe are characterized by having two equal-sized nodes on each flagellar segment of the male antenna, each node containing just one circumfilum. The known females are differentiated from other groups in Hawaii by the extremely long, needle-like ovipositor (fig. 91d).

Only the genus *Contarinia* Rondani and one apparently new genus are known to occur in Hawaii.

Genus **CONTARINIA** Rondani

Contarinia Rondani, 1860, Atti. Soc. Sci. Nat. Milano 2:287.
Eudiplosis Kieffer, 1894, Bul. Soc. Ent. France 63:28.
Stictodiplosis Kieffer, in part, 1894, Bul. Soc. Ent. France 63:28.

This genus is characterized, as is the tribe, by the two equal nodes of the flagellate antennal segments of the male, each with one circumfilum. The palpi are four-segmented; the tarsal claws are simple and are longer than the empodium; the costa is distinctly interrupted after the apex of R_{4+5}; the female ovipositor is very elongate, slender, and needle-shaped; the basistyli of the male are not lobed and the ventral plate of the male genitalia is rather deeply concave on hind margin (fig. 91e). In our species the tip portion of the female ovipositor is covered with scattered minute setae. Felt (1925:155 and 1929:443) said "Rübsaamen has limited this genus [*Contarinia*] to species with the lobes of the ovipositor not pubescent, whereas those with pubescent lobes are referred to the genus *Atylodiplosis* Rübs., type *acetosellae* Rübs. and *Diadaulus* Rübs., type *linaria* Wtz."

Felt (1925:155) separated *Stictodiplosis* Kieffer from *Contarinia* only by the spotted wings of the latter. This does not appear to be a sound character; one of our species has the wings indistinctly spotted and it shows no other characters which would be of generic importance.

It is interesting to note that this genus is apparently absent in the western United States (see Pritchard 1953:143). It is a very large cosmopolitan group containing a number of very important plant pests.

Type of genus: *Tipula loti* DeGeer.

KEY TO SPECIES OF CONTARINIA RONDANI

1. Both dorsal and ventral plates of male rather deeply cleft, about half their length, on hind margin (fig. 90e). Stems of flagellar segments about equal to nodes. Apex of antenna produced into a slender stem (fig. 90c)........... .... **maculipennis** Felt.

   Both dorsal and ventral plates rather shallowly cleft (fig. 91e). Stems one-half to three-fourths as long as nodes. Apex of antenna nodose (fig. 91b)..**sorghicola** (Coquillett).

Contarinia maculipennis Felt (figs. 90a–e).

Contarinia solani Swezey (*nec* Rübsaamen), 1907, Proc. Haw. Ent. Soc. 1:79. Misidentification of *maculipennis*.

Contarinia maculipennis Felt, 1933, Proc. Haw. Ent. Soc. 8:247.

This species is very probably a synonym of *C. lycopersici* Felt, see discussion below.

The Hibiscus Bud Midge

Oahu (type locality: Honolulu), Maui, Hawaii, and probably all of the main islands.

Type in the U.S. National Museum.

Immigrant? Very probably originated in the West Indies.

Host plants: Buds and flowers of hibiscus, tomato, eggplant, pepper, potato, bittermelon, Paraguay nightshade, white cabbage, mustard, and pikake (*Jasminum sambac*).

The taxonomic status of the flower-infesting *Contarinia* in Hawaii has been much confused in the literature. Jensen (1946:525–534) presents biological evidence which indicates that "the tomato infesting midge, which was referred to in the literature as *Contarinia solani* (Rübsaamen) in earlier years and as *C. lycopersici* Felt during recent years, is the same species (*C. maculipennis* Felt) found infesting hibiscus" and many other hosts. His studies indicate that both *C. lycopersici* Felt and *maculipennis* are synonyms of *solani* (Rübsaamen). He stated, however, that "the West Indies *lycopersici* has been recorded only from tomato, while the species in Hawaii is now known to breed in several unrelated plants. This fact makes it inadvisable at present to relegate the name *maculipennis* to synonymy, since the possibility exists that the midge in the West Indies is biologically distinct from the midge in Hawaii despite the apparent absence of consistent morphological differences." Dr. Barnes (Rothamsted Ex-

periment Station, Harpenden, England) in correspondence stated "It is highly probable that these two species [*Contarinia lycopersici* Felt and *C. maculipennis* Felt] are synonyms, but I would prefer to list the Hawaiian hibiscus midge, with its wide host plant range, including tomato, as *C. maculipennis* Felt (1933b) (? = *lycopersici* Felt, 1911), although I think there is no doubt that they are one and the same species." Dr. Barnes also pointed out that *Contarinia solani* (Rübsaamen) (1891) is a distinct European species and the records of it from Hawaii are obviously based upon erroneous identifications.

This species was first recorded in Hawaii in 1906 by Dr. O. H. Swezey (1907:79) under the name *Contarinia solani*. The larvae feed upon the young ovary of the blossoms of tomatoes, hibiscus, and other plants causing the buds and blossoms to blight and eventually fall off. For a detailed account of the host range of this species refer to Jensen (1946) and also to Barnes (1948b:78).

Predominantly yellow to reddish species faintly tinged with brown; slightly more yellowish down each dorsocentral row of the mesonotum. Closely resembling *C. sorghicola* (Coquillett) but distinguished by the characteristics of the antennae and the male genitalia. In the males the stems of the flagellar segments are slender, about equal or longer than the nodes. The basal stem of the fifth antennal segment is two and a half times longer than wide. The apical stem is three and a half times longer than wide. The stems beyond the middle of the antenna are approximately four times longer than wide. The terminal antennal segment is also characteristic; it is drawn out into a slender stem at the apex (fig. 90b). In the female the first flagellar segment is elongated, about two-thirds longer than the second. The stem of the fifth antennal segment is about one-half longer than wide. The stems beyond the middle segments are two or more times longer than wide. The apical segment terminates in a rather slender stem, one-

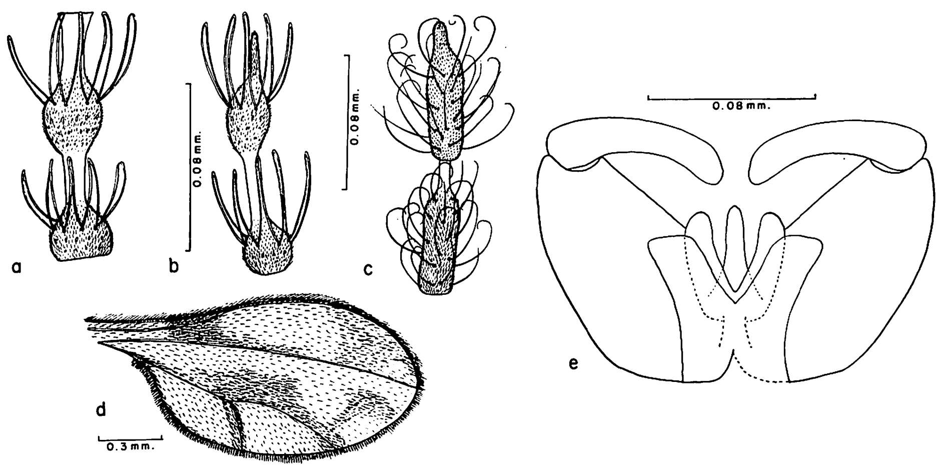

Figure 90—*Contarinia maculipennis* Felt: **a,** fifth antennal segment of male; **b,** apical segment of male antenna; **c,** apical segment of female antenna; **d,** wing; **e,** male genitalia, dorsal view.

third as long as the segment (fig. 90c). The female antennae lack the thread-like circumfila, but have long curled hairs. In *sorghicola* the stems are much shorter and thicker; they are wider than long. The apical segment is indistinctly binodose, the extreme apex is just slightly attenuated, short and thickened; also the antennal segments of the females have the thread-like circumfila (fig. 91c). The male genitalia of the two species differ as shown in figures 90e and 91e. In *maculipennis* the dorsal plate has a broad V-shaped cleft in the middle of the hind margin extending about half the length of the sclerite and the ventral plate is also deeply cleft. The aedeagus is short, rather triangular, and extends just slightly beyond the apex of the ventral plate (fig. 90e). The wings are subhyaline and very indistinctly spotted with fuscous markings. Vein R_{4+5} is straight and ends approximately at the apex of the wing (fig. 90d). The ovipositor of the female is yellowish, about one-half longer than the body, and the apical lobes are slender, about six times longer than wide.

Length: 0.75–1.0 mm.

Contarinia sorghicola (Coquillett) (figs. 91a–e).

Diplosis sorghicola Coquillett, 1898, Div. Ent., U.S. Dept. Agr. n. ser. Bul. 18:82.
Contarinia sorghicola (Coquillett) Felt, 1908, Bul. N. Y. State Mus. 124:393.

The Sorghum Midge

Oahu, Maui, and probably on most of the other islands.

Immigrant. Southeastern United States.

Type in the U.S. National Museum.

Hosts: In growing seeds of sorghum, Johnson, and Sudan grasses.

Parasites: The following have been recorded in the United States and the West Indies: *Aprostocetus diplosidis* Crawford, *Eupelmus popa* Girault, and *Tetrastichus* sp.

According to Dr. E. V. Walter, entomologist, Division of Cereal and Forage Insect Investigations, Bureau of Entomology and Plant Quarantine (1953), "The sorghum midge is one of the most important insects attacking grain sorghums in the southern states. Every year the damage to this crop amounts to several million dollars. Besides damaging the grain sorghums, this pest causes great losses in the seed crops of the sweet sorghums, Sudan grass, and broomcorns. In many sections where the sorghum midge is especially abundant, as much as one-fifth of the crop may be lost, and in years particularly favorable to the midge these sections produce practically no sorghum grain." The midges lay their eggs in the spikelets or seed husks and the small orange-colored larvae damage the grain by feeding on the juices of the developing seed, causing them to dry up and become discolored. The infested grain heads resemble sterile heads and appear blighted or blasted.

The midge was first reported in Hawaii in 1906 by Swezey (1907:79) and is now apparently widespread throughout the lowlands.

For information on the biology and control of this midge see Walter (1953) and Barnes (1956:159–178); the latter is a very thorough account.

The adults resemble those of *maculipennis* in size and coloration but are readily distinguished by the differences in the antennae and the male genitalia as discussed under *maculipennis* and as shown in figures 91c and e. In the males, the stems of the flagellar segments are distinctly shorter than the nodes, the stem of the fifth segment is about one-half longer than wide (fig. 91a), and the apical segment is indistinctly trinodose (fig. 91b). In the female, the first flagellar segment is slightly longer than second and the segments are almost sessile. The stems are very short and the apex of the antenna is short and thick, not with a distinct stem; also thread-like circumfila girdle the segments (fig. 91c). The dorsal plate has a short concavity in the middle of the hind margin. This extends scarcely one-fifth the length of the segment. The ventral plate has a broadly U-shaped cavity and bears a single bristle at apex of each lobe (fig. 91e). The aedeagus is attenuated to a rather sharp point at apex. The wings are hyaline or nearly so. The female ovipositor is as in figure 91d.

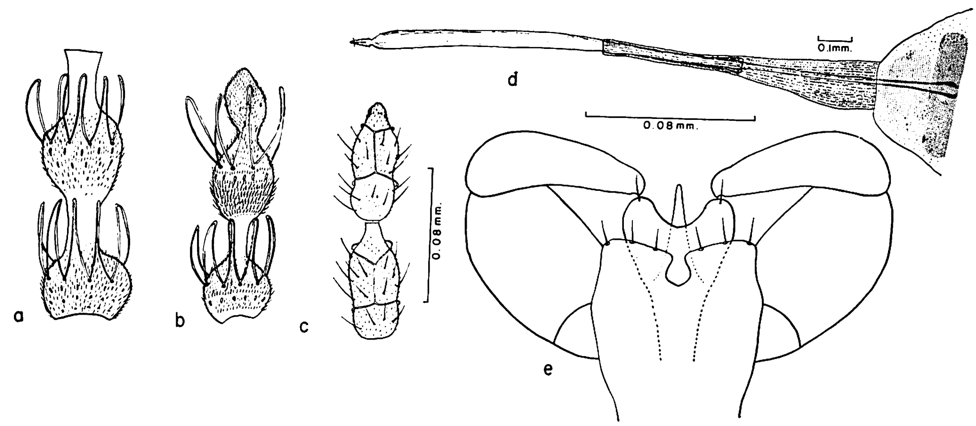

Figure 91—*Contarinia sorghicola* (Coquillet): **a,** fifth antennal segment of male; **b,** apical antennal segment of male; **c,** apical segments of female antenna; **d,** ovipositor; **e,** male genitalia, dorsal view.

Genus **HETEROCONTARINIA, new genus**

A species at hand fits in the *contarinia* complex but is so distinctive from anything that I have seen in the literature that I am describing it as a new genus. In Felt's key (1925:155) it runs to *Procontarinia* Kieffer and Cecconi; but each basistylus has a large spine-like process developed on the inner margin near the basal third, and the ventral plate is rounded, or truncate, at apex, not bilobed, and it does not extend to apex of aedeagus (fig. 92c).

Type of genus: *Heterocontarinia spinosa* n. sp.

Heterocontarinia spinosa, new species (figs. 92a–c).

MALE. A moderately small, entirely pale yellow-white species. *Head:* The eye

bridge is made up of five rows of facets. The palpi are four-segmented, the last three segments are approximately equal in length and about four or five times longer than wide. The antennae are long and slender and 14-segmented. Each flagellar segment is binodose and possesses one circumfilum on each node. The nodes are short, nearly round, and the stems are rather slender; the proximal stem in nearly three times longer than wide and the distal stem is four times longer than wide. The loops of the circumfila are about equal in length to the stems (fig. 92a). The last antennal segment is subacute at the apex (fig. 92b). *Wings:* Hyaline and the membrane is thickly covered with curved microchaetae. Vein R_{4+5} is straight and ends near the wing apex. Cu is forked. The venation is similar to that shown in figure 90d. *Legs:* Entirely pale colored. The tarsal claws are apparently simple on all legs. *Genitalia:* The dorsal plate is rather deeply, but narrowly, cleft on the hind margin, the lobes are rounded. The ventral plate is truncate at the apex, is partly obscured by the spines on the basistyli, and extends just beyond the apex of the dorsal plate. The aedeagus is strongly attenuated apically and extends nearly to the bases of the dististyli. Each basistylus has a strong, inwardly directed, spine on inner edge (fig. 92c). The dististyli are rather small and each has a small tooth at the apex.

Length: wing, 1.5 mm.

FEMALE. Unknown.

Holotype male. Palolo, Oahu, "ex moss" (no date given) (O. H. Swezey).

Type in the Hawaiian Sugar Planters' Association collection.

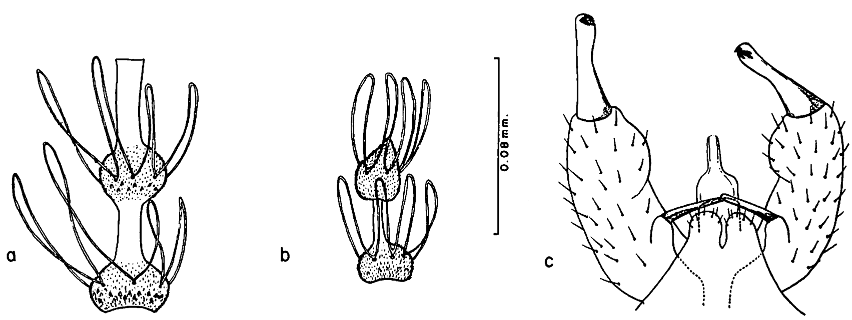

Figure 92—*Heterocontarinia spinosa* n.sp.: **a,** fifth antennal segment of male; **b,** apical antennal segment of male; **c,** male genitalia, dorsal view.

Tribe OLIGOTROPHINI Felt

Dasyneuriariae Felt, 1908, Bul. N. Y. State Mus. 124:335.
Oligotrophiariae Felt, 1908, Bul. N. Y. State Mus. 124:356.
Oligotrophariae Kieffer, 1913, Gen. Ins. 152:34.
Oligotrophini Pritchard, 1953, Bul. Calif. Ins. Surv. 2(2):138.

The members of this tribe are distinguished by having each flagellar segment developed into just a proximal node and a rather long distal stem (fig. 93a).

This group was divided into two tribes by Felt and others on the basis of presence or absence of a tooth on some or all the tarsal claws. Pritchard (1953:138) uses but one tribe, since the development of the teeth on the claws varies considerably. Pritchard says, "Except for the genus *Coccidomyia*, all members of the Oligotrophini feed on higher living plants."

Three genera have been recognized to date from Hawaii. Two (*Mayetiola* Kieffer and *Phaenolauthia* Kieffer), are known only from one or two specimens and have not been identified to species. The other (*Diarthronomyia* Felt) is represented by a common species (*chrysanthemi* Ahlberg) which is the only definitely known gall-former in the islands. *Diarthronomyia* and *Phaenolauthia*, which have at least the front tarsal claws toothed, would fit in Felt's tribe Dasyneurini (as "Dasyneuriariae"). *Mayetiola*, with simple claws, would fit in Felt's "Oligotrophiariae."

Genus **DIARTHRONOMYIA** Felt

Diarthronomyia Felt, 1908, Bul. N. Y. State Mus. 124:339.

This genus is readily recognized by having each flagellar segment developed into only a proximal node and a distal stem (fig. 93a); by the tiny, inconspicuous, two-segmented palpi (fig. 93e); by the presence of a proximal tooth on each of the tarsal claws; by the 17–18-segmented antennae; and by the lack of a radial sector in the wing (fig. 93c).

Type of genus: *Diarthronomyia artemisiae* Felt.

Diarthronomyia chrysanthemi Ahlberg (figs. 93a–e).
Diarthronomyia chrysanthemi Ahlberg, 1939, Ent. Tidskrift 60:274, 278.

Change of name for *D. hypogaea* Felt (1916, Bul. N. Y. State Mus. 186:51) *nec* F. Loew (1885, Verh. Zool.-Bot. Ges. Wien 35:488).

The Chrysanthemum Gall Midge

Oahu, Hawaii, and probably some of the other islands.

Immigrant. Widespread over the United States, Canada, and Europe.

Type in the U.S. National Museum.

Host plants: Various species of the genus *Chrysanthemum*.

Parasites: Essig (1916:466–467) lists two hymenopterous parasites of this species: *Amblymerus* sp. and *Tetrastichus* sp. *Charitopodinus swezeyi* (Crawford) and *Platygaster* sp. have been reared from this species in Hawaii (see Hardy, 1950:19).

This is often a serious pest of chrysanthemums throughout the United States and Europe, especially in greenhouses. It was first reported in Hawaii by Look (1949:332—the generic name misspelled "*Diarthromyia*") damaging leaves and stems of chrysanthemums grown under glass at Hilo, Hawaii. It has since been observed causing severe damage to field-grown chrysanthemums on Oahu (Hardy, 1950:9).

These midges form oval or cone-shaped galls about 2 mm. long on the leaves, stems, and sometimes the blossoms of chrysanthemums. When the infestation is heavy, the portions of the plant above ground may be almost entirely covered with galls, the leaves become badly deformed, the flower buds fail to open or produce malshapen flowers, and the stems are twisted and swollen. It is primarily a greenhouse pest but will attack plants grown out of doors. Barnes (1948b:49) said that in England freshly emerged midges could be found in the field almost any day of the year. The complete development of the larvae and pupae takes place inside the gall, so these stages are fairly well protected from adverse climatic conditions. The eggs are bright red or reddish-orange and are laid in the buds and the folds of the young leaves. The eggs hatch in 3 to 16 days, depending on temperature and humidity; in Hawaii probably 3 to 6 days are required. The larvae bore into the plant tissue and enter the leaf in about a half hour after hatching and become completely enclosed within 24 hours. The galls begin to appear after about 7 days, and the larval stage lasts two weeks to several months (in Hawaii probably not longer than one month is required). The young larvae are milky-white and become reddish-orange as they mature. The pupal stage varies from 6 days to several weeks (probably 6 to 10 days in Hawaii) and generation follows generation. On the mainland of the United States and in Canada, development is retarded during the hot summer and the cold winter months. For detailed accounts of the bionomics and control of this midge, see Barnes (1948b: 46–64), Essig (1916), Felt (1916:51–55), Guyton (1920), and Hamilton (1924).

A rather small delicate midge about 1.5–2.0 mm. in length. Predominantly pale yellowish with three indistinct, slightly brownish, vittae extending longitudinally down the mesonotum. Abdomen of female reddish-orange. Wings hyaline, moderately broad. Vein R_{4+5} reaching the margin slightly below apex of wing. The median vein absent and Cu forked, but weak (fig. 93c). It is easily distinguished from other Hawaiian midges by the generic characters mentioned above. No information seems to be available in the literature as to how this differs from other members of the genus, and I have no other species available for comparison. Pritchard (1953:142) says that in California the identification of the species of this genus is based on the host. The male genitalia are no doubt distinctive for the species. The dorsal plate has a short, narrow, V-shaped cleft in the middle of the hind margin and the posterior lateral lobes are broad and rounded. The ventral plate is narrower than the dorsal, has a narrowly V-shaped cleft on hind margin, and does not extend to the apex of the dorsal plate. Also the aedeagus is rather inconspicuous and does not extend to the apex of the dorsal plate. The dististyli are short and broad and each has a stout, sharp-pointed tooth at apex (fig. 93b). The male antenna is 17-segmented, the stem of the fifth flagellar segment is two-thirds as long as the node and about three and one-half to four times longer than wide. The circumfila are peculiarly developed, consisting of slightly elevated threads girdling the flagellar segments (fig. 93a). The terminal segment is shaped as in figure 93a. The female antenna is made up of 15 distinct segments (the apical portion, however, may be a fusion of two segments); it is constricted near the middle portion but has no distinct suture dividing it. The

stem of the fifth segment is about one-half to two times longer than wide and about one-fourth as long as the node. The palpi of both sexes are tiny, 2-segmented. The female ovipositor is rather elongate; when fully extended it probably is about equal in length to the abdomen (fig. 93d). The tarsal claws are gently curved and each has a proximal tooth. The empodium is well developed, nearly as long as claws.

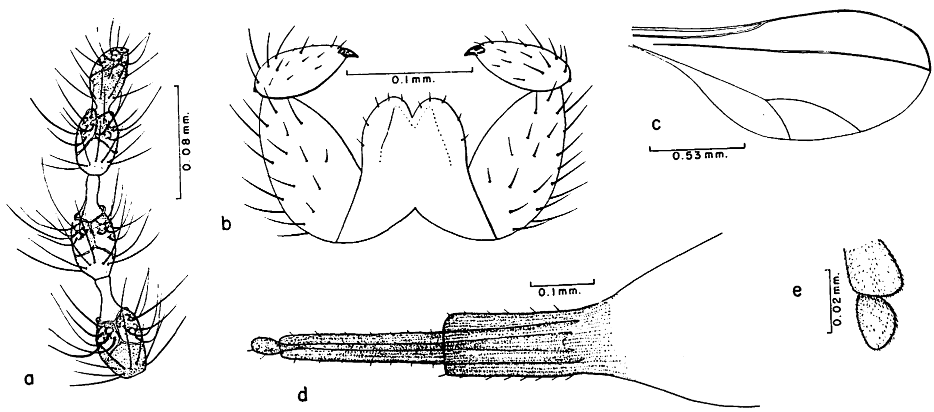

Figure 93—*Diarthronomyia chrysanthemi* Ahlberg: **a,** apical segments of male antenna; **b,** male genitalia, dorsal view; **c,** wing; **d,** ovipositor; **e,** palpus.

Genus **MAYETIOLA** Kieffer

Mayetia Kieffer, 1896, Misc. Ent. 4:5.
Mayetiola Kieffer, 1896, Wien Ent. Zeitg. 15:89. n. n. *pro.*
Mayetia Kieffer, 1896, *nec* Mulsant and Rey, 1875.
Phytophaga Felt, 1916, N. Y. State Mus. Bul. 180:196 (also of many other authors).
Nec Phytophaga Rondani, 1840, Sopra. Alc. nouvi gen. di Ins. Ditt.(2), p. 13.

According to Pritchard (1953:138) the type species of *Phytophaga* Rondani, *salicina* DeGeer, "is regarded by European workers as belonging to either the genus *Rhabdophaga* [Westwood, 1847] or *Dasineura* [Rondani, 1840]. At any rate it appears that the American usage of *Phytophaga* is in error, and that the generic name *Mayetiola* should be employed for these species as it is for similar species in Europe."

As used in this work the *Mayetiola* are distinguished from other Oligotrophini by having the claws simple, the palpi four-segmented, and vein R_{4+5} ending at or near the wing apex. The genus includes a rather large assemblage of species which form galls on various types of plants and a few species which cause severe damage to grains by the larvae sucking the sap from the tissue of the stems. The most notorious member of this genus, and one of the most destructive

species of cecidomyiids, is the Hessian fly, *Mayetiola destructor* (Say) (refer to Barnes, 1956:95–141).

The genus is known in Hawaii by only one species.

Type of genus: *Cecidomyia destructor* Say.

Mayetiola kaalae, new species (figs. 94a–c).

One male specimen from Mt. Kaala, Oahu, November 11, 1926, "ex rotten bark" (O. H. Swezey), cannot be placed to species. Dr. Pritchard studied the specimen and said it "appears to belong to the genus *Mayetiola* (= *Phytophaga* of Felt)." The species at hand should be easy to differentiate because of the distinctive genitalia (fig. 94c).

A small, pale brown species. Antenna not binodose, 12-segmented; the fifth segment about two and one-half times longer than wide, attenuated on apical two-thirds but lacking a clearly differentiated stem. One circumfilum present on each segment, consisting of a thread girdling the central portion (fig. 94a). Palpi four-segmented. Wings hyaline, rather slender, slightly over three times longer than wide. Vein R_{4+5} ends at or very slightly below the wing apex. All claws are simple. The dorsal plate of the genitalia is deeply cleft, the lobes are subacute (fig. 94b). The ventral plate is parallel-sided and truncate at apex. The dististyli are rather short and thick and acute at apices. Each basistylis has a slender subbasal lobe on the inner margin; this extends almost to the apex of the ventral plate (fig. 94c).

Length: wing, 0.7 mm.

Holotype in the Hawaiian Sugar Planters' Association collection.

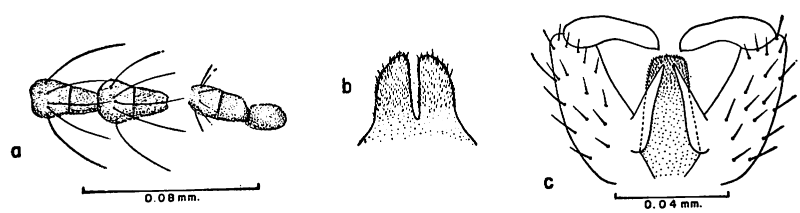

Figure 94—*Mayetiola kaalae* n.sp.: **a,** segments 5 and 6, and apex of male antenna; **b,** dorsal plate of male genitalia; **c,** male genitalia, ventral view.

Genus **PHAENOLAUTHIA** Kieffer

Phaenolauthia Kieffer, 1912, Neue Gallmücken Gattungen, p. 2.

Lasiopteryx Felt, 1915, N. Y. State Mus. Bul. 175:189. *Nec* Stephens, 1829, Nom. Brit. Ins., p. 53.

Kieffer (1913:102) placed this genus in his group (tribe) "Brachyneurariae." Felt (1925:145) put it under "Dasyneuriariae," Edwards (1937:151) put it under "Dasyneurini," and Pritchard (1953:138) has placed it under "Oligotrophini."

The genus is readily separated from other members of the subfamily by the following: the wings are covered with scales; R_{4+5} reaches costa well before wing apex; the palpi are four-segmented; and the claws are toothed only on the front tarsi.

Pritchard (1953:142) says "members of this small genus are believed to be either gall makers or inquilines." The type of the genus (*P. cardui*) has been reared from galls of "*Trypeta cardui*" according to Kieffer (1913:111). He also said that *P. obscuripennis* Kieffer is probably a xylophile. Pritchard said *P. arizonensis* (Felt), the only known species in western United States, has been reared from *Phylloxera* galls on wild-grape leaves.

The genus is known in Hawaii from two female specimens taken in a light-trap collection. It was determined as appearing "to belong to the genus *Phaenolauthia*," by Dr. A. E. Pritchard. The specimen studied by Pritchard had the palpi broken and appeared to be two-segmented.

Type of genus: *Ledomyia cardui* Kieffer.

Phaenolauthia sp.? (figs. 95a–d).

Two female specimens collected in a light trap at Ewa, Oahu, January and December, 1956 (J. W. Beardsley), cannot be placed to species.

A moderately small, pale brown species with the body and legs covered with rather elongate, narrow scales; these are very dense along the costal margin of the wing. Antennae 14-segmented, flagellar segments two to three times longer than wide, stems very short. Each segment has a clump of curled, elongate setae on inner margin. Circumfila consisting of two threads girdling each segment, one just beyond the stem and one near apical two-thirds; these are connected by a transverse commissure (fig. 95a). Palpi four-segmented (fig. 95b). The wings are subhyaline, moderately covered with narrow scales, densely scaled along the costal margin. The radial sector is partially developed and extends almost vertically to R_{4+5}. R_{4+5} ends before the apex of the wing and Cu is forked, with Cu_2 curving down sharply, almost vertical to Cu_1 (fig. 95c). The female ovipositor is not extended; the lobes (cerci) of the genitalia are oval and densely setose (fig. 95d).

Length: approximately 1.5 mm.

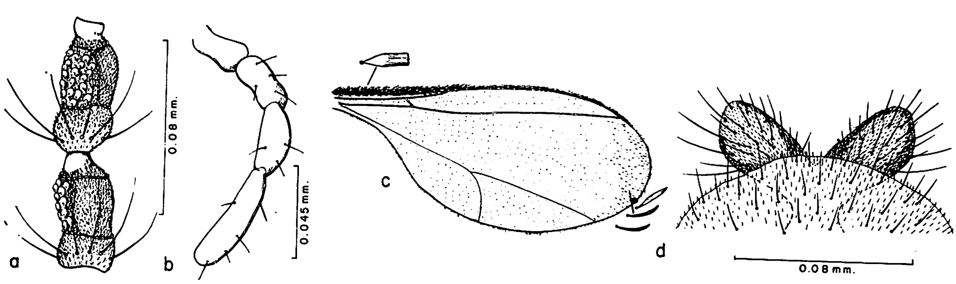

Figure 95—*Phaenolauthia* sp.?: **a,** antennal segments 5 and 6; **b,** palpus; **c,** wing; **d,** ovipositor.

Tribe EPIDOSEINI Kieffer

Epidosides Kieffer, 1898, Bul. Soc. d'Hist. Nat. de Metz (2)8:42.
Epidosariae Kertesz, 1902, Cat. Dipt. 2:128; Felt, 1908, Bul. N. Y. State Mus. 124:415.
Porricondylariae Kieffer, 1913, Gen. Ins., Fasc. 152:258.
Porricondylini Pritchard, 1953, Bul. Calif. Ins. Surv. 2(2):133.
Epidoseini Pritchard, 1956, in correspondence.

The members of this tribe differ from other Cecidomyiinae by having a well-developed radial sector in the wing. According to Pritchard (1953:133) the known larvae of species of this tribe are saprophagous or fungivorous. He says that the "adults are found in well-shaded, damp woodlands." Only one species each of the genera *Johnsonomyia* Felt and *Porricondyla* Rondani have been taken in the Islands. To date these are known only from female specimens taken in light traps.

Genus **JOHNSONOMYIA** Felt

Johnsonomyia Felt, 1908, Bul. N. Y. State Mus. 124:417.

Two females from light-trap collection on Oahu and sent to Dr. A. E. Pritchard were identified as *Johnsonomyia*. The specimens were evidently misplaced or lost in the mails and are not available for illustrating or describing.

The members of this genus are apparently differentiated from other Epidoseini by having the cubital vein simple, the Rs forming an oblique angle with R_{4+5}, and the palpi four-segmented. The antennae lack circumfila; the flagellar segments are covered with long setae.

The Hawaiian species has not been identified.

Type of genus: *Johnsonomyia rubra* Felt.

Genus **PORRICONDYLA** Rondani

Porricondyla Rondani, 1840, Mem 2a per ser. alla Ditt. Ital. Parma, p. 14.
Epidosis Loew, 1850, Dipt. Beitr. 4:20.

This group apparently is characterized by having the radial sector well developed; the cubital vein forked; the palpi four-segmented; the pulvilli rather well developed and the tarsal claws simple and gently curved. The species at hand (represented only by females) would probably not fit in *Porricondyla sens. str.* If Kieffer's concept (1913:259) is followed, *Porricondyla* is restricted to those species which have the flagellate antennal segments of the male globose and those of the female elongate and constricted in the middle. The female specimens at hand have the flagellate segments subcylindrical and would seem to fit *Phaenepidosis* Kieffer in the key. Specimens were sent to Dr. A. E. Pritchard and he agreed that they were *Porricondyla*. Obviously the group is very badly in need of revision. Pritchard (1953:134) said "a large number of species have been described in the genus *Porricondyla*, and a revision is needed before identifications can be made.

A single species has been recorded from the West" [*P. barberi* Felt].
Type of genus: *Cecidomyia albitarsis* Meigen.

Porricondyla sp.? (figs. 96a–b).

An entirely pale colored, predominantly white species which cannot be placed until males are discovered. It would appear to differ from all the species which I have seen in the literature by having 24 segments in the antennae. Felt (1916:166) says the females usually have 12–14 antennal segments.

Antennae, legs, halteres, and abdomen entirely white, rather thickly covered with long white hairs. The thorax is predominantly white but is yellow-white on the mesonotum except for a white line down each dorsocentral row. The flagellar segments have the nodes about one-half longer than wide, the stems are scarcely two times longer than wide and on most segments the stem is about one-half as long as the node (fig. 96a). The pulvilli are moderately well developed and about half as long as the claws. The claws are simple and gently curved. The wings are hyaline, the venation as in figure 96b. Two large sac-like spermathecae are present. These are not sclerotized, are completely transparent and each is slightly over half as wide as the abdominal segments.

Length: body, 1.5 mm.; wings, 2.4 mm.

MALE. Unknown.

To date, nine specimens have been taken in light traps at the following locations: Ewa, Oahu, October-November, 1955 (J. W. Beardsley); Waipio, Oahu, November, 1956 (J. W. Beardsley); Honolulu, Oahu, October, 1951 (B. Defibaugh); and Hilo, Hawaii, December, 1945 (W. W. Wirth).

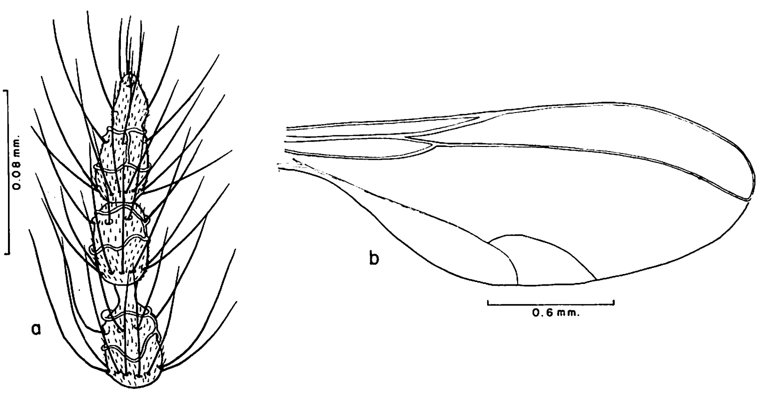

Figure 96—*Porricondyla* sp.?: **a,** apical segments of antenna; **b,** wing.

Tribe CECIDOMYIINI Kieffer

Diplosariae Felt, 1908, Bul. N. Y. State Mus. 124:381.

Cecidomyiariae Kieffer, 1913, Gen. Ins. 152:17.
Itonididinariae Felt, 1915, Bul. N. Y. State Mus. 175:79.
Trifili White, 1950, Univ. Texas Pub. 5007:8.
Itonidini Pritchard, 1953, Bul. Calif. Ins. Surv. 2(2):144.
Trifilini Rao, 1955, Agra Univ. Jour. Res. (Sci.) 6(1):254.

This is the largest group in the family and includes all Cecidomyiinae which lack a well-developed radial sector and the males of which have binodose antennae with the nodes unequal in development and with two circumfila on the distal node of each segment (fig. 97a). Males are necessary for the identification of most species. The females are very difficult to place to genus or species and for the most part cannot be satisfactorily differentiated from contariniines or oligotrophines, unless accompanied by the male.

Members of this tribe are very diversified structurally as well as biologically. The group includes species which are predators on other insects and mites, fungus feeders, and gall-makers.

Almost half of the presently known Hawaiian species belong in this tribe. To date 11 genera and 14 species are treated under Cecidomyiini.

Genus **ARTHROCNODAX** Rübsaamen

Arthrocnodax Rübsaamen, 1895, Wien Ent. Zeit. 14:189.
Feltodiplosis Kieffer, 1913, Gen. Ins. 152:154.

This genus is differentiated from others of the group trifila which have all claws simple by the following characters: vein R_{4+5} ends before the wing apex; the empodium is well developed, nearly as long as claws; the stems of the flagellar segments are about as wide as long (fig. 97a) and the circumfila are rather short; the dististyli of the male genitalia are short, thickened at bases and apices; dorsal plate has a U-shaped cleft in the middle of the hind margin and ventral plate is rounded at apex. Also the aedeagus is short, not reaching apex of ventral plate. The female ovipositor is short with two large lamellae.

Felt (1925:163) says the ventral plate of *Arthrocnodax* is deeply lobed; our species may not properly fit here. *Arthrocnodax* is very close to *Microdiplosis* Tavares, but that genus has longer stems on the flagellar segments, the ventral plate is much longer than the dorsal and is enlarged, slightly emarginate at apex (fig. 103b). *Microdiplosis* also has vein R_{4+5} curved sharply upward so that cell R_1 is narrow, sharp-pointed at apex (cf. figs. 97e and 103a); also the antenna of the females of *Microdiplosis* has but 13 segments.

According to Felt (1918a:81), it is probable that most species are zoophagous. Several species are known to feed upon tyroglyphid mites, red spider mites (*Tetranychus*), and eriophyid mites; *Arthrocnodax* have also been reported feeding upon scale insects, *Pulvinaria* and *Pseudococcus* spp. One Mainland species, *A. apiphila* Felt, has been found to be a rather general predator, having been taken feeding on mites, scales, and upon the forest caterpillars *Malacosoma disstria*.

A. walkeriana Felt is the only species which has been identified from Hawaii.

Two other species are at hand, represented only by one female each, which have been identified as *Arthrocnodax* by Pritchard. These will run with *A. walkeriana* Felt in the key to known females of Cecidomyiinae but differ by having very short stems on the flagellar segments (almost sessile). One species is characterized by having the costal margin thickly covered with narrow scales and the tip of the last segment of antenna rounded, as well as differing in wing venation and other details. The other species is distinguished by having the Rs rather well developed but short and vertical in position; also the tip of the last antennal segment is slightly attenuated. These species cannot be placed until males are discovered.

Type of genus: *Arthrocnodax vitis* Rübsaamen.

Arthrocnodax walkeriana Felt (figs. 97a–f).

Arthrocnodax walkeriana Felt, 1915, Jour. N. Y. Ent. Soc. 23:181.

Oahu. Taken feeding on mealybugs at Honolulu and in light traps at Ewa and Waipio. Determination confirmed by Dr. R. H. Foote, who compared specimens from Oahu with the type in the U.S. National Museum.

Immigrant. Ceylon (type locality: Peradeniya).

Type in the U.S. National Museum.

Hosts: Previously known only from the original specimens reared (in 1914) from "a *Pseudococcus* on coffee" and from "*Walkeriana* sp., probably *kandyense.*" As pointed out by Barnes (1930:319), and as confirmed (in correspondence) by Drs. G. F. Ferris, Stanford University, and H. Morrison, U.S. National Museum, there seems to be no record of this species. *Pseudococcus kandyensis* Green seems to be the only definitely established combination using the name *kandyensis*. In Hawaii this has been reared from *Saccharicoccus sacchari* (Cockerell), at Honolulu, October 5, 1915, and July 15, 1930 (O. H. Swezey); from *Dysmicoccus boninsis* (Kuwana), at Honolulu, August 9, 1930 (O. H. Swezey); and from *Pseudococcus adonidum* (Linnaeus), at Honolulu, February, 1955 (J. W. Beardsley). A series is at hand labeled "H.S.P.A., 8-III-10. Bred ex dry insect debris ex sugar cane stalks. Reddish larvae feeding on dry insect debris" (F. X. Williams). These probably were feeding on sugarcane mealybugs.

Small reddish yellow species characterized by the details of the antennae, wings, and genitalia. MALE. Antennae as long as the body, 14-segmented, thickly haired; circumfila rather short, not quite as long as nodes. Proximal stem of fifth antennal segment but little longer than wide, distal stem about two times longer (fig. 97a). Distal node of last segment oval (fig. 97b). Palpi as in figure 97d. Second and third segments approximately equal, fourth segment about one-half longer than third. Legs pale yellow, claws all simple, evenly curved; empodium nearly as long as claws. Wings hyaline; R_{4+5} straight, entering costa distinctly before apex; M absent; Cu forked (fig. 97e). Basistyli and dististyli rather short and thick. The former each with a densely pilose, evenly rounded, basal lobe; the latter with a small tooth at apex. Dorsal plate short with a narrowly U-shaped cleft extending about half its length. Ventral plate extending beyond dorsal

plate, spatulate in shape, and rounded apically (fig. 97f). Aedeagus not extending beyond apex of ventral plate.

Length: 1 mm.

FEMALE. Stem of fifth antennal segment nearly one-half longer than wide and almost one-half as long as node. Apical segment oblong, two and a half times longer than wide, rounded at apex (fig. 97c).

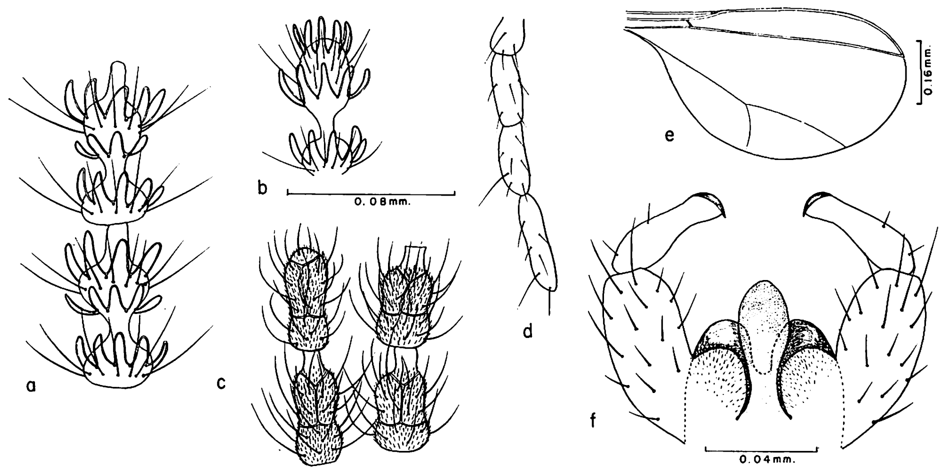

Figure 97—*Arthrocnodax walkeriana* Felt: **a,** fifth and sixth segments of male antenna; **b,** apical segment of male antenna; **c,** apical and fifth and sixth segments of female antenna; **d,** male palpus; **e,** wing; **f,** male genitalia, ventral view.

Genus **COCCODIPLOSIS** de Meijere

Coccodiplosis de Meijere, 1917, Tijdsch. v. Ent. 60:238.

One male and one female labeled "ex pineapple, Honolulu, Oahu, Sept. 1922 (D. T. Fullaway)" apparently belongs here. The male was sent to Dr. Pritchard, who said it "could be referred to *Coccodiplosis*, inasmuch as it appears to be similar to the description of *C. citri* Barnes. However, the palpus in your specimen appears to be two-segmented (as in *Mycocecis*) and the pectinate cusp of the disticlasper is distinctive." The female specimen has three distinct segments in the palpi and I believe the third has been broken off on the male specimen.

Based upon the type of the genus, *Coccodiplosis* is apparently characterized by having three moderately short circumfila on each segment of the antenna; by having all the claws toothed; by having the palpus three-segmented; by having the Rs straight and extending to apex of wing; by the dorsal plate of the male genitalia being rather deeply cleft, the ventral plate nearly truncate, and the aedeagus extending just slightly beyond tip of ventral plate (see fig. 1–d. de Meijere, 1917:240).

Type of genus: *Coccodiplosis pseudococci* de Meijere. This is evidently a general

mealybug-feeder. In Java it has been recorded preying upon *Pseudococcus crotonis* Green, *P. adonidum* (Linnaeus), *Planococcus citri* (Risso), and *Ferrisiana virgata* (Cockerell).

Coccodiplosos ananasae, new species (figs. 98f–j).

The species at hand is apparently closely related to *C. citri* Barnes (1935:526) described from specimens found feeding on *planococcus citri* (Risso) in Pretoria, South Africa. From the original description of *citri* it has not been possible to conclusively differentiate the Hawaiian specimens from that species. Dr. H. F. Barnes has kindly sent me two cotypes (♂ and ♀) of *C. citri*, and it is obviously different from our species. In *citri* the distal node of each flagellar segment of the male is nearly two times longer than wide (fig. 98a); in *ananasae* this node is about as wide as long (fig. 98f). In *citri* the aedeagus is elongate, extending to about apices of claspers; rather than to about bases of claspers. In *citri* the dorsal plate is more deeply cleft, the cleft extending nearly to bases of the basistyli and the claspers are rather slender, not expanded apically and with an apical hook but with no distinct pectination at apices (fig. 98c). In *ananasae* the cleft of the dorsal plate extends a little over half the distance to the bases of basistyli and the claspers are short and thick, enlarged at apices and with strong pectination around apex (fig. 98h). In the females the third segment of the palpus is nearly two times longer than the second in *citri* and is but slightly longer in *ananasae* (fig. 98g). Also the nodes of the flagellar segments of *citri* are from two and a half to two and two-thirds longer than wide and possess 8–10 sensory setae, arising from large bases, on the upper surface. In *ananasae* the nodes of the flagellar segments are slightly less than two times longer than wide and the sensory setae are more sparse (fig. 98g).

MALE. Mostly yellow or yellow-red, tinged with brown on the mesonotum and on the abdominal terga. Palpi not clearly visible on the specimen at hand (only two segments visible, the third is apparently broken off). Basal node of fifth antennal segment about two-thirds as long as the apical node; circumfila short, about equal to the length of the nodes. Basal stem of the fifth segment about as long as wide; apical stem twice as long as wide. Circumfila of apical node short, about equal to the length of the apical stem (fig. 98f). All claws are toothed (fig. 98j), the secondary tooth is long and well developed; the claws are rather strongly curved. Wings hyaline; vein R_{4+5} straight, extending to apex of wing; Cu forked. Dorsal plate of male genitalia rather deeply cleft. Ventral plate nearly truncate apically, parallel sided. Aedeagus extending slightly beyond the dorsal plate. Dististyli moderately short and thick and pectinate at apices (fig. 98h).

Length: body, 1.2–1.4 mm.; wings, 1.0–1.15 mm.

FEMALE. Like the male in most respects. The palpi are 3-segmented (fig. 98i). Antennae 12-segmented, the flagellar segments cylindrical and about two and one-half times longer than wide; the stems are short and thick, slightly wider than long (fig. 98g). The apical segment is about three times longer than wide and is obtuse. Lobes of ovipositor rather broad and rounded.

Holotype male and allotype female, Honolulu, Oahu. September, 1922, "ex Pineapple" (D. T. Fullaway). Both have been deposited in the B. P. Bishop Museum.

This species may possibly be a predator on the pineapple mealybug, *Dysmicoccus brevipes* (Cockerell).

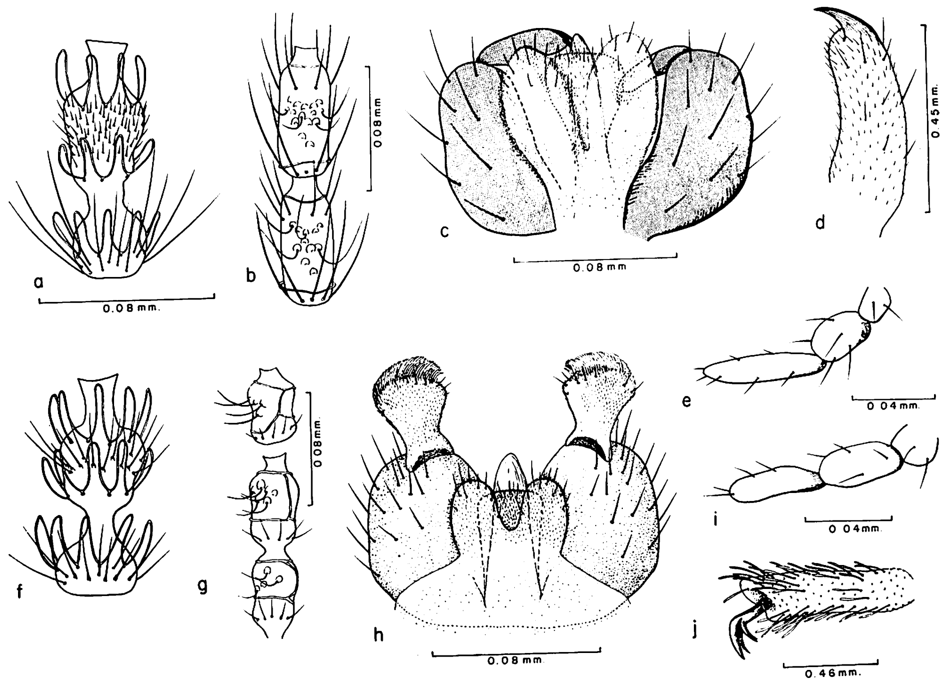

Figure 98—*Coccodiplosis citri* Barnes: **a,** fifth antennal segment of male; **b,** fifth and sixth antennal segments of female; **c,** male genitalia, dorsal view; **d,** male diststylus; **e,** palpus of female. *C. ananasae* n.sp.: **f,** fifth antennal segment of male; **g,** basal and fifth flagellar segments of female antennae; **h,** male genitalia, dorsal view; **i,** palpus of female; **j,** last tarsal segment.

Genus **DICRODIPLOSIS** Kieffer

Dicrodiplosis Kieffer, 1895, Bul. Soc. Ent. France for 1895:194.

This belongs in the group of trifila which have the claws toothed on all legs, palpi 4-segmented, circumfila about equal, without any greatly produced bows or loops, and the tarsal claws not strongly curved at nearly right angles. The only species which has been introduced into Hawaii can be readily recognized by the distinctive genitalia of the male (fig. 99c) and by the trinodose flagellar segments of the male antennae (fig. 99b).

The genotype is European and is apparently known only from the female. It is probable that some of the North American species ascribed to this genus do not belong here. Felt's concept was rather heterogeneous and included both gall-

makers and predators. The genus is closest to *Thomasiniana* Strand; according to Pritchard (1953:144) it is distinguished by having the claws evenly and shallowly curved, rather than sharply curved at right angles.

Type of genus: *Dicrodiplosis fasciata* Kieffer.

Dicrodiplosis guatemalensis Felt (figs. 99a–c).
Dicrodiplosis guatemalensis Felt, 1938, Proc. Haw. Ent. Soc. 10:43.

Not known to be established in Hawaii.

This species is predaceous on mealybugs and was introduced into Oahu in 1935, from Guatemala, by Dr. Walter Carter, in an attempt to establish it on the pineapple mealybug (*Dysmicoccus brevipes* (Cockerell)). There is no record of its having become established. Dr. Carter says the larvae are brilliant carmine and are very conspicuous.

Type in the U.S. National Museum. I have studied cotypes in the Pineapple Research Institute collection, Honolulu.

It is possible that this species does not properly belong in *Dicrodiplosis;* Felt tentatively referred it to this genus.

Rather dark-colored midges. Palpi 4-segmented. Antennae 14-segmented; in the males the distal stems are one-half longer than wide and the proximal stems are about one-half their diameter, the basal enlargement is globose and the apical portion of each segment is about two times longer than wide and slightly constricted in the middle, trinodose (fig. 99b). Circumfila moderately numerous and with the length about equal to the diameter of the nodes. Thorax brown, tinged lightly with rufous in the ground color, scutellum reddish yellow, faintly tinged with brown especially on the margin. Halteres yellow-white. Abdomen yellowish, densely yellow haired. Legs brown, thickly haired, narrow apices of femora and tibiae white or yellowish; first tarsal segment white, others banded with white at apices; distal tarsal segments of posterior legs yellow-white. Claws long, strongly curved, unidentate; empodium rudimentary. Wings gray, rather thickly haired. Vein R_{4+5} reaches the margin at the apex. Vein M is absent although the fold of the wings at this point may appear like a vein in some lights. Cubitus forked, upper fork very faint; Cu_2 bent down at a right angle (fig. 99a). The genitalia of the male are yellowish, large, and conspicuous. The dististyli are long and slender, curved upward, and almost as long as basistyli. The genitalia are characterized by the presence of a pair of sharp-pointed spine-like or tooth-like lobes on each side of the aedeagus; the inner pair of these appears to be accessory structures of the aedeagus and are probably the "harpes" referred to by Felt; the outer pair seem to be lobes of the basistyli (fig. 99c). The dorsal plate has a narrow cleft in the middle of the hind margin and the lobes are broadly rounded. The ventral plate is just slightly broader than the aedeagus, is not lobed at apex, and extends almost to the apex of the dorsal plate. (See figure 99c and note that the ventral plate has been pulled forward in the figure to show its shape.) I cannot follow all of Felt's description of the genitalia: he says, "dorsal plate triangularly emarginate, the lobes tapering and narrowly rounded; ventral plate

long, divided, the lobes long, slender, and broadly rounded; harpes broadly sickle-shaped."

The female antenna is about one-half as long as the body. The fifth flagellar segment has a stem about one-fourth the length of the cylindrical node; the node is approximately five times longer than wide. The ovipositor is short and the lobes are elongate, broadly rounded, with a length about five times their width, and rather densely setulose.

Length: 1.5 mm.

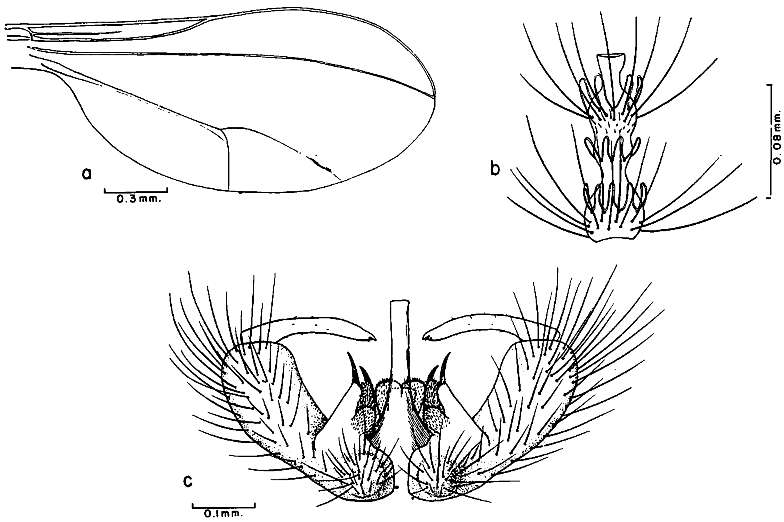

Figure 99—*Dicrodiplosis guatemalensis* Felt: **a,** wing; **b,** fifth antennal segment of male; **c,** male genitalia, ventral view.

Genus GIARDOMYIA Felt

Giardomyia Felt, 1908, Bul. N. Y. State Mus. 124:405.

In Hawaii the known species of *Giardomyia* may be distinguished from other Cecidomyiini by the long slender ventral plate of the male genitalia (fig. 100b). This fits in the group of trifila which have all claws simple and vein R_{4+5} curved downward, ending well below the apex of the wing; the circumfila are moderately developed and the claws are bent at nearly right angles and slightly enlarged near their apices. The basistyli are not lobed at bases, the ventral plate extends nearly as long as the aedeagus and has a shallow V-shaped cleft at apex, and the dorsal plate is rather short with a rather deep V-shaped cleft (fig. 100b). In the Hawaiian species the radial sector is rudimentary, but at least a portion of the vein is present and is fairly distinct compared to most other Cecidomyiini; these may easily be confused with the Epidoseini which have a distinct radial sector.

Two species have been recognized from Hawaii. They have been taken only in light traps and nothing is known of their biology. In other places, several of

the species of this genus are known to be gall-formers on various plants. Dr. R. H. Foote, United States Department of Agriculture, has confirmed that our species are "certainly congeneric with Felt's generic type" of *Giardomyia*.

Type of genus: *Giardomyia photophila* Felt.

Key To Giardomyia Felt

1. Thorax all yellow except for brown scutellum and halteres. Abdomen and legs brown, joints narrowly white. Genitalia as in figure 100f . . . . **pallidithorax** n. sp.
   Mesonotum largely brown, scutellum and halteres yellow. Legs yellow, lightly tinged with brown, and abdomen brownish yellow. Genitalia as in figure 100b . **furvescens** n. sp.

Giardomyia furvescens, new species (figs. 100a–b).

Structurally this species is very close to *G. pallidithorax* n. sp., but it differs strikingly in coloration. The chiefly brown mesonotum, yellowish scutellum and halteres, and paler colored legs and abdomen will easily differentiate it. Also the aedeagus is not constricted into a distinct nipple at apex (fig. 100b).

MALE. *Head:* Palpi 4-segmented, last segment about one-third longer than the penultimate. Antenna yellow-brown. The basal node of each flagellar segment nearly round, as wide as long; the basal stem about three times longer than wide and distinctly longer than the node; the loops of the circumfilum of the basal node almost as long as the stem. The distal node of each segment one-half to two times longer than wide and more swollen on the apical portion; the distal stem nearly four times longer than wide and about equal in length to the node, and the loops of the distal circumfilum nearly as long as the stem. The apical portion of the antenna drawn out into a slender pubescent point about two-thirds as long as the last node. *Thorax:* As described above, mesonotum predominantly brown, scutellum and halteres pale, the former often tinged with brown. *Legs:* As in *pallidithorax* except that they are yellow, tinged with brown. *Wings:* Hyaline. Vein R_{4+5} curved downward, meeting the costa below the apex. Rs fairly distinct. Cu forked. Cu_2 extending to margin, almost vertical in position (fig. 100a). *Abdomen:* Yellow, tinged with brown. Genitalia yellow-white. Much like *pallidithorax* but the aedeagus more straight sided, not constricted at apex and the ventral plate narrower, scarcely wider than the aedeagus (fig. 100b). The basistyli also each have a small bump at the base as seen in ventral view.

Length: body, 1.2 mm.; wings, 1.65 mm.

FEMALE. Colored as in the male. The stems of the antennae are two-thirds to three-fourths as long as the nodes, and the apical prolongation is about half as long as the node of the last segment.

Holotype male (on slide): Ewa, Oahu, light trap, April, 1955 (J. W. Beardsley). Allotype female (on slide): Waipio, Oahu, light trap, November, 1955 (J. W. Beardsley). About 75 paratypes, sexes about evenly distributed, most were taken at light and a few on windows from the following localities: same as type, April to December, 1955; same as allotype; Honolulu, Oahu, January, 1953 (D. E.

Hardy); Manoa Valley, Oahu, October, 1938 (E. H. Bryan, Jr.); Waialua, Oahu, July–August, 1953 (D. E. Hardy); Hilo, Hawaii, December, 1945 (W. W. Wirth); Keaau Orchard, Olaa, Hawaii, September, 1956, and Lihue, Kauai, November, 1956, light trap (C. Isenberg).

This is one of most common species attracted to lights and is probably present in the lowlands on all of the main islands.

Type, allotype, and a series of paratypes in the Hawaiian Sugar Planters' Association collection. Remainder of the paratypes in the following collections: B. P. Bishop Museum, U.S. National Museum, British Museum (Natural History), and the University of Hawaii.

Giardomyia pallidithorax, new species (figs. 100c–f).

This species is readily differentiated from all other Hawaiian gall midges by its conspicuously pale yellow thorax and by the brown scutellum, halteres, and legs. It seems to differ from any of the species which I have seen in the literature. Dr. Foote has studied specimens and said that it appears to be distinctly different from any of the North American species. Aside from the distinctive color features mentioned above, it is distinguishable from other Hawaiian *Giardomyia* by the constriction of the aedeagus into a distinct nipple (fig. 100f).

MALE. Almost entirely brown, except for the pale yellow thorax. *Head:* Antennae and palpi brown, tinged with yellow, the latter 4-segmented with the second and third segments approximately equal and the apical segment about one-fourth longer than the third and slightly swollen on distal half. The basal node of each flagellar segment is about as wide as long; the apical node is nearly two times longer than wide and swollen on the distal half of the node. The proximal stem of each flagellar segment is about two and one-half times longer than wide and the distal stem is about three and one-half times longer than wide. The loops of the circumfila are nearly equal to the stems of the nodes (fig. 100d). The apical segment is drawn out at the tip into a slender, densely pubescent point which is half as long as the apical node (fig. 100e). *Thorax:* As described above with only the scutellum and knobs of halteres brown. A line down each dorso-central row is paler colored than the remainder of the thorax. A few conspicuous yellow-brown dorsocentral setae are present on the front portion of the mesonotum and a few smaller setae are present along the sides of the mesonotum. *Legs:* Brown, narrowly ringed with pale yellow to white on the joints, and with yellow hairs. Tarsal claws simple; each is bent sharply at nearly a right angle just beyond the middle. Empodium rather well developed, extending as far as the bend in the claw. *Wings:* Hyaline, rather thickly covered with pale brown microtrichia. Vein R_{4+5} curved downward and ending distinctly below the apex of the wing. Rs present but not as distinctly developed as in the Epidoseini. Vein Cu is forked, Cu_2 extends almost vertical to the wing margin. *Abdomen:* Dark brown, genitalia yellow. Dististyli slender, enlarged slightly at bases. Basistyli not lobate and scarcely longer than the dististyli. Dorsal plate cleft almost half its length in the middle of the hind margin; the two lobes are rounded and extend to about a level with the apices of the basistyli. The ventral plate is rather slender, nearly

straight sided beyond the dorsal plate, very slightly expanded apically; it extends much beyond the dorsal plate and has a shallow V-shaped concavity at apex. The aedeagus extends beyond the tip of the ventral plate and the apex is markedly constricted (fig. 100f).

Length: body, 1.15–1.3 mm.; wings, 1.6–1.75 mm.

FEMALE. Colored as in the male. The stems of the flagellar segments are slender, almost equal in length to the nodes, the apical two segments are as in figure 100c. Ovipositor not extended; lobes of the cerci oblong.

Holotype male and allotype female (on slides): Waipio, Oahu, January, 1956, light trap (J. W. Beardsley). Forty-three paratypes, sexes about evenly distributed, all from light traps or taken at lights, at the following locations: same as type; Ewa, Oahu, November-December, 1955 (J. W. Beardsley); Honolulu, Oahu, January, 1953, and November, 1955; Manoa Valley, Oahu, December, 1951 (M. S. Adachi); and Lihue, Kauai, November, 1956 (Carl Isenberg).

Type, allotypes, and some paratypes in the Hawaiian Sugar Planters' Association collection. Remainder of paratypes are in the following collections: U.S. National Museum, B. P. Bishop Museum, British Museum (Natural History), and the University of Hawaii.

It is probable that this species is found on all of the main islands.

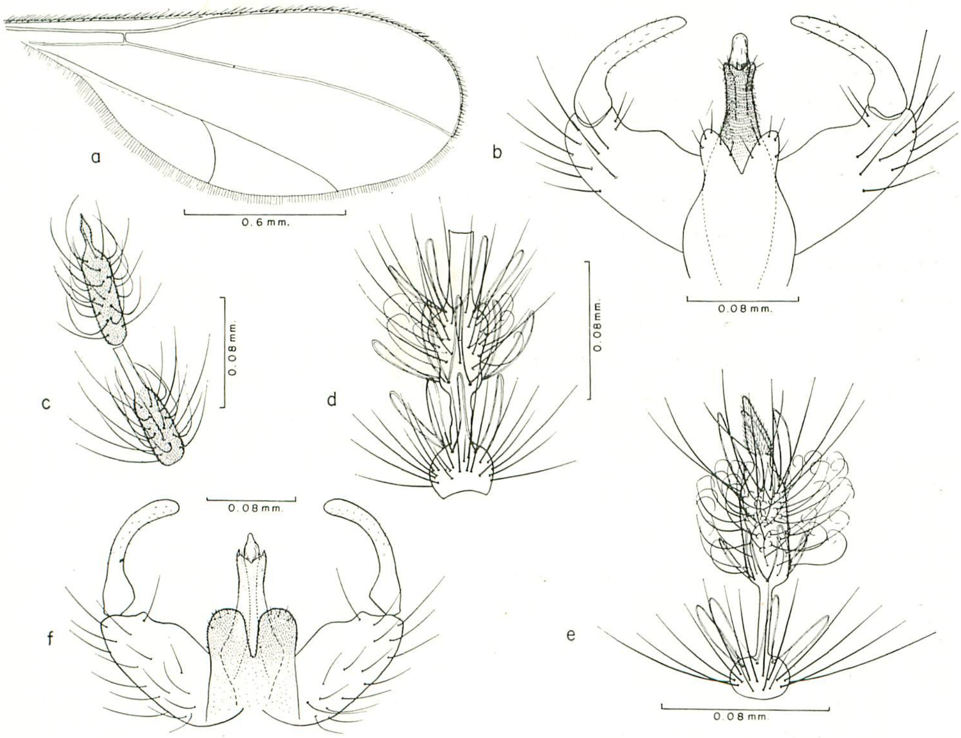

Figure 100—*Giardomyia furvescens* n.sp.: **a,** wing; **b,** male genitalia, dorsal view. *G. pallidithorax* n.sp.: **c,** apical segment of female antenna; **d,** fifth antennal segment of male; **e,** apical antennal segment of male; **f,** male genitalia, dorsal view.

Genus **LESTODIPLOSIS** Kieffer

Leptodiplosis Kieffer, 1894, Bul. Soc. Ent. France, for 1894:28.
Lestodiplosis Kieffer, 1894, Bul. Soc. Ent. France, for 1894:280.
Hemidiplosis Kieffer, 1894, Ami de Sci. Nat. 1:9.
Coprodiplosis Kieffer, 1894, Feuille Jeun. Natural. 24:84.

In the original description Kieffer spelled the name "*Leptodiplosis*" (page 28). In the same number of the bulletin, on page 280, he listed the name but this time spelled it *Lestodiplosis*. This is apparently the way he had meant to spell the name in the first place; he used *Lestodiplosis* consistently in all of his publications except for the original, and there is no indication in the literature that Kieffer even noticed the incorrect spelling. No statement was made regarding an emendation of the name, and he apparently never mentioned *Leptodiplosis* again in his writings. Neave (Nomen. Zool.) cites *Lestodiplosis* as an "err. pro *lepto*-Kieffer 1894." Coquillett (1910, Type Species of known American Genera of Diptera, Proc. Nat. Mus. 37:559) cites *Leptodiplosis* as the valid name, with no mention of the name *Lestodiplosis*. *Lestodiplosis* Kieffer has, however, been used consistently throughout the taxonomic literature on this family, and in order to avoid any future confusion I have appealed to the International Commission for Zoological Nomenclature to stabilize the name by putting it on the Official List of Generic Names in Zoology and to place the name *Leptodiplosis* on the Official List of the Rejected Generic Names (see Hardy, 1956a).

Coprodiplosis Kieffer has been separated from *Lestodiplosis* by having the wings hyaline, rather than spotted as in typical *Lestodiplosis*. Felt (1921:128) has treated this as a subgenus, pointing out that considerable intergradation is seen in the wing markings and the character is variable in some species; the wings may also be spotted in the female and hyaline in the males. It is apparently impossible to draw a sharp line between those with spotted and unspotted wings and the character seems of little generic or subgeneric value in this case.

This genus is easily distinguished from others of the tribe in Hawaii by the characteristic triangular or rounded setulose lobe at the base of each basistylus (fig. 101h). All of the claws are simple, not bent at right angles; the palpi are four-segmented; vein R_{4+5} ends slightly below the apex of the wing; the dorsal plate of the male genitalia has a broadly V-shaped cleft on hind margin and the ventral plate is rounded at apex, not lobate (fig. 101h).

Very little is known of the habits of the Hawaiian species. They have been taken in light traps, reared from manure and rotting vegetation, and taken in a Berlese funnel. According to Kieffer, the larvae are zoophagous, feeding upon the larvae of other cecidomyiids, other flies and insects, and mites. In other regions they are often reared from the galls of other species of gall midges. This is a large, widespread genus; two species are known to occur in Hawaii.

Type of genus: *Lestodiplosis septemguttata* Kieffer. Designated by Kieffer (1894:280); later (1913:196) Kieffer indicated *L. alternans* Kieffer as the genotype.

Key to Species of Lestodiplosis Kieffer

1. Wings hyaline. Legs and antennae not banded. Lobe of each basistylus triangular. Dorsal plate with a shallow, broadly V-shaped cleft on hind margin (fig. 101c)..... **fimicola** n. sp.

   Wings spotted. Legs and antennae with brown to black bands. Lobes of basistyli obtuse. Dorsal plate with a deep narrow cleft (fig. 101h)............... **obtusilobata** n. sp.

Lestodiplosis fimicola, new species (figs. 101a–e).

I have not been able to place this species in the literature. It seems to fit near *L. scrophulariae* Felt (Felt, 1921:131), but the distal stem of the fifth antennal segment is not three and one-half times longer than wide and the circumfila are moderately long, not short. Dr. R. H. Foote compared some of our specimens with the type of *L. scrophulariae* in the U.S. National Museum and said, "It is certainly not *scrophulariae* Felt, if only because of the length of the circumfilae." In Felt's key it probably would better fit the character "abdomen fuscous yellowish" (couplet dd, p. 131), but the stems of the fifth antennal segment are about two and one-half times longer than wide, not three and one-half, and the other characters in this section do not fit. This key is very unsatisfactory and the entire group is obviously badly in need of revision. Felt's description of *L. scrophulariae* (1921:141) contradicts the statement he makes in his key. In the description, he says fifth antennal segment "with stems having a length one and one-half and three and one-half times their diameters respectively." In his key he says the basal stem is two and one-half times its diameter. I have no way of evaluating the importance of the slight differences in the lengths of the antennal stems and slight differences in body coloration; some of these characters seem rather trivial. This is possibly the *Lestodiplosis* sp. reported by Barnes (1928:103) "bred from fowl dung" in Samoa. The specimens he had were in poor condition and he did not describe them. He said, "No other species of this genus is known to breed in fowl dung." It probably feeds as a predator upon other insects that develop in decaying organic materials.

This would fit in the subgenus *Coprodiplosis* Kieffer since the wings are hyaline; but this character is of questionable subgeneric value, and I am not recognizing this group.

MALE. A pale yellow species tinged lightly with brown. *Head:* Antennae yellow-brown. The basal stem of the fifth segment is about two and one-half times longer than wide, the distal stem is three and one-half times longer. The circumfila are moderately well developed, approximately equal in length to the nodes (fig. 101a). Apical antennal segment with a long slender stem between the nodes; this is over four times longer than wide and is about equal in length to the apical node. The latter terminates in a short blunt point (fig. 101b). *Thorax:* Largely yellow with some brown markings on the mesonotum. *Legs:* Yellow, tinged with brown and

densely covered with brown hair. Claws simple, gently curved; empodium about three-fourths as long as the claws. *Wings:* Faintly gray fumose. Vein R_{4+5} straight and ending at apex of wing. *Abdomen* and *Genitalia:* Chiefly yellow. Each basistylus with a sharp-pointed lobe near base. Dorsal plate cleft about half its length on hind margin, the lobes are rounded at apices. The ventral plate is rounded at apex and extends just slightly beyond the apex of the dorsal plate. The aedeagus is long, slender, and rod-shaped, extending beyond apices of basistylus (fig. 101c).

Length: body, 1.0 mm.; wings, 1.3 mm.

FEMALE. Stems of antennal segments three and one-half times longer than wide and almost as long as the nodes (fig. 101e). The apical segment is rounded at apex and has no stem (fig. 101d). Lobes of ovipositor two to two and one-half times longer than wide.

Holotype male and allotype female (mounted on slides): bred from poultry manure, University of Hawaii campus, Honolulu, June 29, 1946 (Y. Tanada). About 75 paratypes (sexes about evenly distributed): most of these same data as type. Others from Honolulu, reared ex rotten mango, October 10, 1933 (O. H. Swezey); reared from rotting sweet potato, January–July, 1953 (M. Adachi and D. E. Hardy); Honolulu, in Berlese funnel, October, 1951 (W. C. Mitchell); and Ewa, Oahu, in light trap, December, 1955, to January, 1956 (J. W. Beardsley).

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. Remainder desposited in the following collections: U.S. National Museum, British Museum (Natural History), Hawaiian Sugar Planters' Association, and University of Hawaii.

Lestodiplosis obtusilobata, new species (figs. 101f–h).

A spotted-winged species with striped legs and antennae. It seems to fit best in *Lestodiplosis* but the basal lobes of the basistyli are obtuse and in this regard it would fit *Orseoliella* Kieffer in Felt's key (1925:167). I doubt that this character is of much value and the group should not be divided just on the amount of development of these lobes. Dr. R. H. Foote, at the U.S. National Museum, has examined specimens of this species and says (in correspondence) it "certainly does not belong to *Orseoliella*. According to Kieffer's (Gen. Ins. p. 152 and figs.) illustrations, the style is much too short and stout, and the dististyles much too stout in *Orseoliella*. In addition, the female of that genus has five circumfilae per segment, all connected by short filae parallel with the longitudinal axis of the segment." *L. obtusilobata* fits fairly near *L. raphani* Barnes (1929:119–120), reared from stored seeds in Denmark and Germany (probably a mite predator); this too has obtuse basal lobes on the basistyli. Dr. Foote said *L. raphani* differs from this species by having "a much stouter style and a different wing pattern, in addition to much shorter male circumfilae and less extensive brown markings on the antennal segments."

MALE. Predominantly pale colored species. *Head:* Antennae 14-segmented, chiefly pale yellow-white, banded with brown at apices of distal stems and on each proximal node. Circumfila moderately developed, those of proximal node

of each segment extend about to the base of the distal node; the basal circumfilum of each distal node is rather short, the loops are about as long as the node and the loops of the apical set extend as far as base of next segment. The basal stem of the fifth segment is three to three and one-half times longer than wide and the apical stem is two and one-half times longer than wide (fig. 101f). *Thorax:* Yellow, tinged with brown above and rather densely gray pollinose on the mesonotum. All hairs yellow. Halteres white. *Legs:* Predominantly yellow-white, brown to black at apices of femora, apices and bases of tibiae, all of metatarsi and fifth tarsal segment, and narrow apices and bases of tarsal segments two to four. Claws simple, gently curved. *Wings:* Spotted with brown, as in figure 101g, with two large spots in cell R_1, two in cell R_5 (plus a small, indistinct basal spot), one each on veins Cu_1 and Cu_2, and one in middle of cubital cell. Vein R_{4+5} straight or nearly so, ending at wing apex. *Abdomen:* Yellow, terga one to four often tinged with brown. Rather thickly yellow haired. Genitalia yellow-white. Basistyli each with a densely haired, obtuse basal lobe. Dorsal plate cleft about one-third its length, the cleft narrow and sometimes inconspicuous. The ventral plate is slightly longer than the dorsal and is not bilobed. The aedeagus extends well beyond the ventral plate, is slightly enlarged at apex, and nearly truncate (fig. 101h).

Length: body, 0.8–1.0 mm.; wings, 1.2–1.4 mm.

FEMALE. Similar to the male. Bases of nodes brown, stems about equal in length to nodes.

Holotype male (mounted on a slide): Waialua, Oahu, light trap, May, 1953 (J. W. Beardsley). Allotype female (mounted on a minuten nadeln): Ewa, Oahu, light trap, December, 1955 (J. W. Beardsley). Forty-three paratypes, predominantly males, from the following localities: same as type, May–August, 1955; same as allotype, September–December, 1955; Kalihi, Oahu, no date (O. H. Swezey); Marsh Trail, Oahu, December, 1935 "Straussia" (O. H. Swezey); Honolulu, Oahu, at light, January, 1953–November, 1955 (D. E. Hardy); Waipio, Oahu, January, 1956 (J. W. Beardsley); and Waihee, Maui, at light, June, 1952 (D. E. Hardy).

Type, allotype, and a series of paratypes at Hawaiian Sugar Planters' Association. Remainder in the following collections: U.S. National Museum, British Museum (Natural History), B. P. Bishop Museum, and the University of Hawaii.

Genus **LOBODIPLOSIS** Felt

Lobodiplosis Felt, 1908, Bul. N. Y. State Mus. 124:397.

The members of this genus are small, orange or yellowish orange forms characterized by the presence of a distinct apical lobe on each basistylus of the male, by the unidentate claws on the anterior tarsi, and the trinodose flagellar segments of the male of most species. The species at hand has the flagellar segments very indistinctly trinodose and the apical lobe of each basistylus is strongly developed, extending well beyond the dististylus.

This genus seems to fit near *Phaenobremia* Kieffer, but lacks the greatly

produced bows or loops of the circumfila and the genitalia are very different (compare figs. 102b, 102d, 106a, and 106c).

Only one species is known to occur in Hawaii.

Type of genus: *Mycodiplosis acerina* Felt.

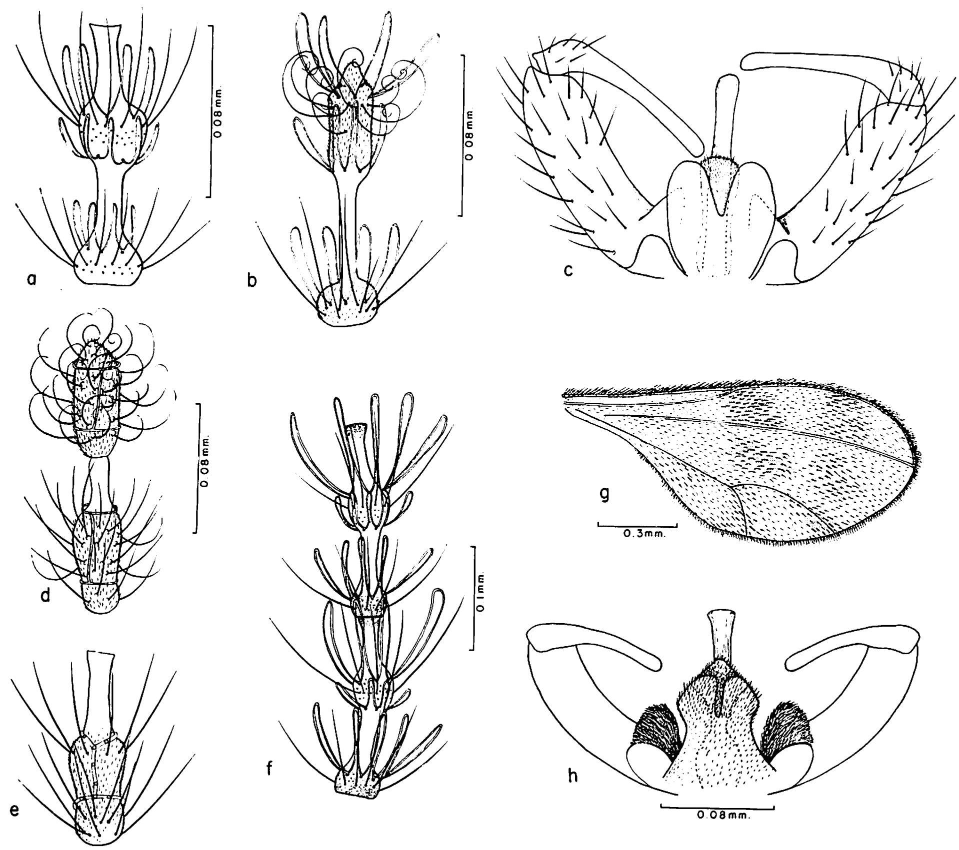

Figure 101—*Lestodiplosis fimicola* n.sp.: **a,** fifth antennal segment of male; **b,** apical antennal segment of male; **c,** male genitalia, dorsal view; **d,** apical segment of female antenna; **e,** fifth antennal segment of female. *L. obtusilobata* n.sp.: **f,** fifth and sixth antennal segments of male; **g,** wing; **h,** male genitalia, dorsal view.

Lobodiplosis pseudococci Felt (figs. 102a–d).

Lobodiplosis pseudococci Felt, 1933, Jour. N. Y. Ent. Soc. 41:87.

Oahu (type locality: Kunia), Maui, and probably on other islands.

Immigrant. Introduced from Mexico in 1930 by Mr. Fullaway of the Board of Agriculture and Forestry as a predator on the pineapple mealybug, *Dysmicoccus brevipes* (Cockerell). Specimens reared from *D. brevipes* in Jamaica, Honduras,

Guatemala, and Brazil (in connection with the parasite exploration work done by the Pineapple Research Institute) have also been examined.

It was first recovered in 1933 (Chock, 1933:237) and a year later was reported (Schmidt, 1934:360) as being well established in some pineapple fields on Oahu. In the vicinity of Honolulu this has been reared from *Saccharicoccus sacchari* (Cockerell); from mealybugs on *Solanum* sp.?; mealybugs on *Ceratonia* (*Pseudococcus vastator* (Maskell)) and from *Planococcus citri* (Risso) on banana.

Type in the U.S. National Museum.

Felt tentatively referred this to the genus *Lobodiplosis* because of the apical lobe on the basistylus. The genitalia differ from other known species by having the apex of the basistylus more strongly produced, the dististylus short and broad, vein R_{4+5} straight and reaching the costa at or slightly before apex, and the flagellar segments of the male antennae not so distinctly trinodose.

The mesonotum and abdominal terga are brown, tinged with yellow. Scutellum, pleura, and sides of abdomen yellow. Legs mostly brown to black, femora largely yellow, the dorsal edge brownish. Antennae 14-segmented; in the male the circumfilum of basal enlargement forms rather stout loops extending to the base of the distal enlargement and the distal circumfilum extends to base of the following segment. The basal and distal stems of each segment are approximately equal in length. Those of the fifth segment are two to two and one-half times longer than wide (fig. 102b). Wings broad, not much over two times longer than wide; hyaline, densely haired; costa dark brown. Vein R_{4+5} straight or nearly so reaching margin at or slightly before apex. Vein Cu forked (fig. 102a). Claws stout, curved at right angles; the anterior claw unidentate. Empodium rudimentary. Both the dorsal and ventral plate of the male genitalia rather deeply cleft on hind margin. Each basistylus produced at apex into a strong, sharp-pointed lobe extending as far as the apex of the aedeagus and slightly beyond the dististylus. The dististylus arises near the inner median margin of basistylus, is short and broad, has a short

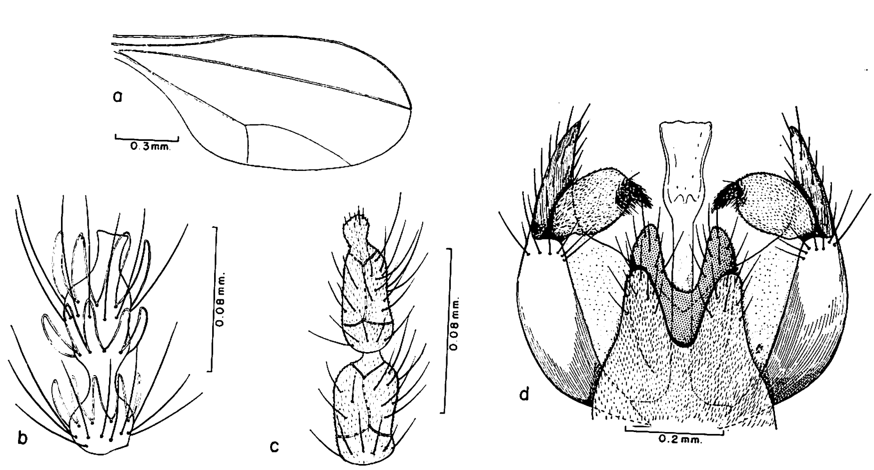

Figure 102—*Lobodiplosis pseudococci* Felt: **a,** wing; **b,** fifth antennal segment of male; **c,** apical segment of female antenna; **d,** male genitalia, dorsal view.

tooth at apex above, and the apical portion is densely pubescent. The aedeagus is expanded at apex (fig. 102d).

Length: 1.0 mm.

The flagellar segments of the female have short stems, that of the fifth about one-fifth the length of the basal enlargement. Each segment is girdled by a pair of thread-like rings, and the apical segment is slightly expanded knob-like at the tip (fig. 102c). Ovipositor short; the original description said that it was about one-half as long as abdomen, but in our specimens the ovipositor consists of just a pair of oblong lobes.

Length: 1.5 mm.

Genus **MICRODIPLOSIS** Tavares

Microdiplosis Tavares, 1908, Boteria, Ser. Zool. 7:155.

Fitting most of the characters for *Arthrocnodax* Felt but differing by having vein R_{4+5} curved upward so that cell R_1 is narrow and sharp-pointed at apex (fig. 103a); by having the stems of flagellar segments two or more times longer than wide and the ventral plate much longer than the dorsal and enlarged and emarginate apically; also by basistyli not being lobed at bases, and the female antenna with but 13 segments.

A small genus. The previously known species have all been reared from plant galls; the genotype was reared from mite-caused galls. The species are probably all predators. One Hawaiian species seems to fit here.

Type of genus: *Microdiplosis zambezensis* Tavares.

Microdiplosis beardsleyi, new species (figs. 103a–e).

The species at hand seems to fit in the genus *Microdiplosis*, but I am unable to ally it to any of the species I have seen in the literature. In the Hawaiian fauna it fits closest to *Arthrocnodax walkeriana* Felt but is distinguished by the characters given in the generic key above or by the characters depicted in the figures of the wings, antennae, and male genitalia (figs. 97e, 97f, 103a, and 103 b).

MALE. Predominantly pale yellow-orange with brown discolorations on the mesonotum. *Head:* Palpi 4-segmented, rather short, the last three segments about equal in length. Antennae 14-segmented, basal node of each flagellar segment slightly wider than long and apical node oval. The stems of the nodes are two to three times longer than wide and about equal in length to the width of the nodes. The circumfila are about equal in length to the stems (fig. 103c). The apical node of the last segment is just slightly produced at its tip (fig. 103c). *Thorax:* Mesonotum discolored with brown, scutellum and pleura pale yellow. *Legs:* Yellow, tinged lightly with brown. Claws simple, gently curved; empodium nearly as long as the claws. *Wings:* Hyaline. Vein R_{4+5} ending well before wing apex and arched upward toward the apical portion so that the apex of cell R_1 is narrowed and pointed (fig. 103a). Cu forked, Cu_2 extending to wing margin. *Abdomen* and *genitalia:* Pale colored. Dististyli and basistyli short and not lobate. Dorsal plate

cleft about one-third its length in middle of hind margin. Ventral plate slightly expanded at apex and with a shallow apical concavity; the ventral plate extends well beyond the dorsal. The aedeagus extends beyond the apex of the ventral plate (fig. 103b).

Length: wing, 0.8–1.0 mm.

FEMALE. Colored like the male. Antennae 13-segmented, stems of flagellar segments about two times longer than wide and about half as long as the nodes. Each node with two raised thread-like circumfila girdling the segment (fig. 103e). The apical segment is cylindrical, slightly over three times longer than wide, with no apical attenuation, and with four of the thread-like circumfila girdling the segment (fig. 103d). Ovipositor not extruded.

Holotype male (on slide): from Ewa, Oahu, light trap, November, 1955 (J. W. Beardsley). Allotype female: same data as type except December, 1955. Five paratypes (all males, on slides): same data as type and allotype.

Type and allotype in the Hawaiian Sugar Planters' Association collection. The paratypes distributed among the following collections: U.S. National Museum, B. P. Bishop Museum, and the University of Hawaii.

It is a pleasure to name this species in honor of J. W. Beardsley of the Hawaiian Sugar Planters' Association. He collected (in light traps) much of the material used in this study.

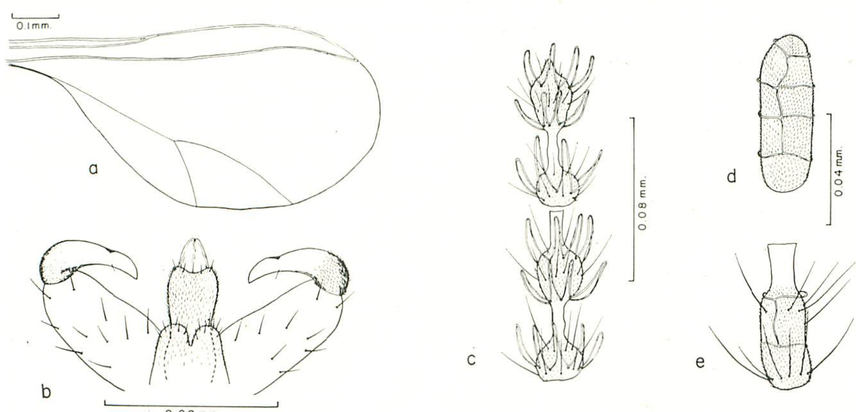

Figure 103—*Microdiplosis beardsleyi* n.sp.: **a,** wing; **b,** male genitalia, dorsal view; **c,** fifth and apical antennal segments of male; **d,** apical segment of female antenna; **e,** fifth antennal segment of female.

Genus NANODIPLOSIS Kieffer

Nanodiplosis Kieffer, 1913, Bul. Soc. Hist. Nat. Metz 28:55.

A trifila having the claws all simple, the palpi 4-segmented, and vein R_{4+5} ending in the costa below the wing apex. It fits in the group of genera which have

short circumfila on the flagellar segments of the male and is distinguished (by Felt, 1925:165) from related genera by having spotted wings. The species at hand, which fits here, has the dorsal and ventral plates rather deeply cleft on the hind margins. The latter is slightly longer than the dorsal plate, and the aedeagus extends nearly to the tips of the lobes of the ventral plate. The basistyli and claspers are simple; both are rather slender.

One Hawaiian species fits here.

Type of genus: *Nanodiplosis squamosus* Kieffer.

Nanodiplosis pucciniacola, new species (figs. 104a–c).

I have been unable to find this species in the literature. It seems to fit in the genus *Nanodiplosis* but I have not been able to place it to species. It appears somewhat like *Clinodiplosis pucciniae* Pritchard, which was reared from rust spores in California, but all of the claws are simple and gently curved; not with the claws abruptly bent near bases and those of front tarsi each with an elongate, strongly curved proximal tooth. Also, the spotted wings of *pucciniacola* and the differences in the male genitalia will differentiate the two; see figure 104c and Pritchard's figure 1 (1948:30).

MALE. A predominantly pale yellow species with white pile on the body and legs. *Head:* Palpi 4-segmented, the apical segment slender and equal in length to the two basal segments combined. Scape and pedicel of antenna yellow, flagellum brownish yellow; the latter with 12 segments. The circumfila are very short (fig. 104b), their length is less than the width of each node. The basal stem of each node is about as wide as long, and the apical stem is nearly two times longer than wide. The apical antennal segment is rather drawn out at the tip (fig. 104b). *Thorax:* Brown above, with a narrow yellow vitta extending down each dorsocentral line. Scutellum yellow. *Legs:* Pale yellow, slightly tinged with brown. Claws simple, gently curved. *Wings:* Spotted with brown as in figure 104a. Vein R_{4+5} very slightly curved and ending just below wing apex. Cubitus forked, both branches extending to wing margin. *Abdomen:* Reddish yellow to yellow. *Genitalia:* Dorsal plate rather narrowly and deeply cleft. Ventral plate slender, straight-sided, just slightly longer than the dorsal plate, and bilobed at apex with the lobes rather sharply pointed (fig. 104c). Aedeagus extending approximately to the apex of the ventral plate. Dististyli simple, basistyli somewhat swollen on inner edge basally (fig. 104c).

Length: body, 0.75–0.90 mm.; wings, 1.3 mm.

FEMALE. Much like the male. The nodes of the flagellum are about two and one-half times longer than wide and the stems are just slightly longer than wide. The ovipositor is not protruded and the cerci are oblong to oval in shape.

Holotype male (on slide): Kailua, Oahu, May 28, 1954, reared on *Puccinia* on *Geranium* (L. M. Chilson). Allotype female: Ewa, Oahu, December, 1955, in light trap (J. W. Beardsley). About 40 paratypes, sexes rather evenly distributed, from the following localities on Oahu: same data as type; same as allotype; Waipio, January, 1956, light trap (J. W. Beardsley); Kawaihapai, April 29, 1930, ex rust

on *Euphorbia thymifolia* (O. H. Swezey); Kaimuki, December 20, 1919, at light (O. H. Swezey); and Honolulu, January, 1953, at light (D. E. Hardy).

Type, allotype, and a series of paratypes in the B. P. Bishop Museum. Remainder of paratypes in the following collections: U.S. National Museum, Hawaiian Sugar Planters' Association, British Museum (Natural History), and the University of Hawaii.

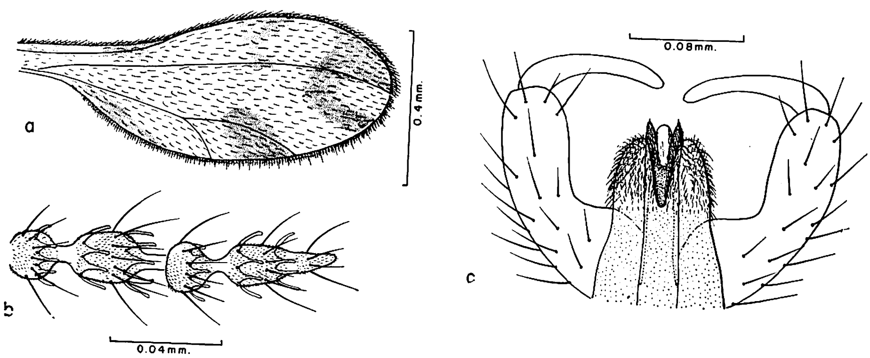

Figure 104—*Nanodiplosis pucciniacola* n.sp.: **a**, wing; **b**, apical segments of male antenna; **c**, male genitalia, dorsal view.

Genus **PARALLELODIPLOSIS** Rübsaamen

Parallelodiplosis Rübsaamen, 1910 Zeitsch. Wiss. Ins. 6:287.
Clinodiplosis Felt (nec Kieffer), 1908, Bul. N. Y. State Mus. 124:411.

The members of this genus are small yellowish species which have simple, gently to strongly curved tarsal claws; 4-segmented palpi; circumfila moderately developed and not irregular; vein R_{4+5} meeting the costa beyond the apex of the wing; the basistyli not lobed; the ventral plate linear, rounded at apex or distinctly concave and extending beyond apex of dorsal plate.

The species whose biologies are known breed in leaf and root galls on various plants.

Type of genus: *Diplosis galliperda* F. Loew.

The above generic concept may be too broad and may include two genera. See discussion under *P. cattleyae* (Molliard).

Key to Parallelodiplosis Rübsaamen (Sens. Lat.)

1. Wings hyaline. Tarsal claws strongly bent at a right angle (fig. 105f). Ventral plate concave on hind margin (fig. 105e). Gall-former on roots of orchids (not known to be established) . . . . **cattleyae** (Molliard).

Wings with two prominent black spots (fig. 105a). Tarsal claws gently curved. Ventral plate rounded at apex (fig. 105b) .... **bimaculata** n. sp.

Parallelodiplosis bimaculata, new species (figs. 105a–b).

This species seems to fit the characteristics of *Parallelodiplosis* but the wing markings and the details of the male genitalia differ from those species known to me or which I have found in the literature. The two prominent black spots on the anterior margin of the wing make it easy to recognize.

MALE. A small predominantly pale, yellow-white species with faint brown markings on the mesonotum. *Head:* Antennae yellow-brown; the circumfila are moderately developed and are about equal in length to the stems of the nodes; both the distal and proximal stems of the fifth segment are about three times longer than wide. Palpi lacking sensory pits; first segment one-half second; second and third equal; fourth one-third longer than third. *Thorax:* Brownish yellow on the dorsum with a yellow-white vitta down each dorsocentral line and yellow-white on sides of mesonotum. Scutellum white. *Legs:* Predominantly yellow-white, apices of tibiae brown; basitarsi brown to black; tarsi 2 and 3 with narrow bands of black at extreme apices and bases; segments 4 and 5 all brown to black. Tarsal claws simple, gently curved. *Wings:* Vein R_{4+5} very slightly curved, ending at the wing apex with two large black spots on anterior margin just beyond apex of vein R_1 and one at apical third of wing (fig. 105a). *Abdomen* and *genitalia:* Largely yellow-white. The dorsal plate is bilobed; the ventral plate is rounded, slightly tapered to the apex. The aedeagus is long and slender, extending to apices of dististyli (fig. 105b).

Length: body, 0.57 mm.; wings, 0.61 mm.

FEMALE. Similar to the male except for the usual sexual differences. The stems of the antennal segments are rather long, almost as long as the nodes and about two and one-half to three times longer than wide. The lobes of the ovipositor are about three times longer than wide.

Holotype male and allotype female (mounted on microscope slides): from Ewa, Oahu, light trap, November, 1955 (J. W. Beardsley). Forty-five paratypes (sexes about evenly distributed) from the following localities on Oahu, all taken at light: same as type; Waipio, December, 1956 (J. W. Beardsley); Waialua, May and August, 1953 (D. E. Hardy); and Honolulu, January, 1953 (D. E. Hardy).

The type, allotype, and a series of paratypes are in the collection of the Hawaiian Sugar Planters' Association. The remainder of the paratypes are in the following collections: U.S. National Museum; B. P. Bishop Museum, and the University of Hawaii.

Parallelodiplosis cattleyae (Molliard) (figs. 105c–f).

Cecidomyia cattleyae Molliard, 1902, Marcellia 1:165.
Clinodiplosis cattleyae Felt, 1908, Bul. N. Y. State Mus. 124:412.

Oahu?; not known to be established.

Immigrant. Central America, England, France, and the United States.

Host plants: According to Barnes (1948b:92), they attack various species of *Cattleya* and *Laelia purpurata* orchids. Molliard (1902:165–170) recorded it from *C. sanderiana* Hort., *C. mendeli* Hort., *C. mossiae* Parker, *C. warneri* Moore, and *L. purpurata* Lindl. and Paxt.

This midge has been intercepted at Honolulu a number of times in galls on the roots of imported *Cattleya* orchids. It is not known to be established in the Islands (refer to Fullaway 1938:48 and Swezey 1945:336) but is included here since there is such a potential danger of this being an important orchid pest in Hawaii.

Felt (1921:172) reported *Cattleya gigas* as the host plant of the midges he described. Swezey (1945:336) reported that the midge had been intercepted in Honolulu on *Cattleya mendeli*, *C. triumphans*, *C. warscewiczii*, *C. gigas sanderiana*, and *Laeliocattleya* species from England.

The midges form elongate galls on the aerial roots of the orchids. According to Barnes (1948b), "The galls are conspicuous swellings, sometimes attaining the length of 2 cm. and 1 cm. in diameter, but usually about the size of a large pea; several larvae are to be found in the same gall but each larva lives in a separate cavity. Besides being unsightly, the galls reduced the growth of affected plants very noticeably."

The following description is quoted from Felt (1921:172–173): Male. Length 2 mm. Antennae probably nearly as long as the body, sparsely haired, black; 14 segments, the fifth with stems having a length one and one-half and two and one-half times their diameters respectively. Palpi; the first segment probably quadrate, the second broadly oval, with a length one-half greater than its diameter, the third longer, the fourth probably as long as the third. Color red, with a faint, dusky shade (Pergande). Wings hyaline, costa yellowish brown. Genitalia; dorsal plate short, roundly emarginate; ventral plate long, deeply and roundly emarginate, the lobes narrowly rounded; style long, slender, narrowly rounded.

Female. Length 2.5 mm. Antennae nearly as long as the body, sparsely haired, black; fourteen segments, the fifth with a stem three-fourths the length of the cylindric basal enlargement, which latter has a length two and one-half times its diameter; terminal segment produced, the basal enlargement with a length three and one-half times its diameter, apically a fingerlike process. Palpi; first segments subquadrate, the second narrowly oval, with a length over twice its width, the third a little longer than the second, more slender, the fourth one-half longer than the third, dilated. Color black. Ovipositor short, the terminal lobes narrowly oval (Pergande) subacute.

Larvae identified as this species have been intercepted a number of times at the Quarantine Station in Honolulu, but the adults have not been seen in Hawaii. No adults were available in the U.S. National Museum or the British Museum (Natural History), but I was able to borrow a male and a female, for study, from Dr. H. F. Barnes, Harpenden, England.

In addition to Felt's description quoted above, in the specimens at hand the antennae of both sexes are yellow, tinged with brown; in the male each node has a ring of strong bristles and is rather densely covered with brown to black microscopic setae. The loops of the circumfila are about as long as the nodes (fig. 105c). The apical segment of antenna terminates in a gradually tapered process which is equal in length to the last node (fig. 105d). Tarsal claws bent at right angles (fig. 105f). Vein R_{4+5} curved downward meeting the costa well below the apex

of the wing. I would not consider the dorsal plate roundly emarginate; it has a V-shaped cleft in middle of hind margin extending half the length of the segments and the lobes are acute at apices. The ventral plate extends beyond the dorsal, about level with apices of basistyli and has a small V-shaped cleft at the apex (fig. 105e). The specimens studied are predominantly yellow, faintly tinged with brown.

Dr. Richard H. Foote, of the U.S. National Museum (in correspondence) has said, "We receive from time to time a considerable number of larvae from Central American orchids belonging to several genera other than *Cattleya*. The interception men call these *Parallelodiplosis cattleyae*, but to my knowledge none have been reared to adults, and I'm inclined to believe a number of species are involved." The larvae are yellow or pale orange with a brown "breast bone."

I question whether this species actually fits in *Parallelodiplosis* because the claws are bent at right angles and the ventral plate is lobate. It would seem to me to fit nearer to *Giardomyia* Felt, and I see no good characters for separating it.

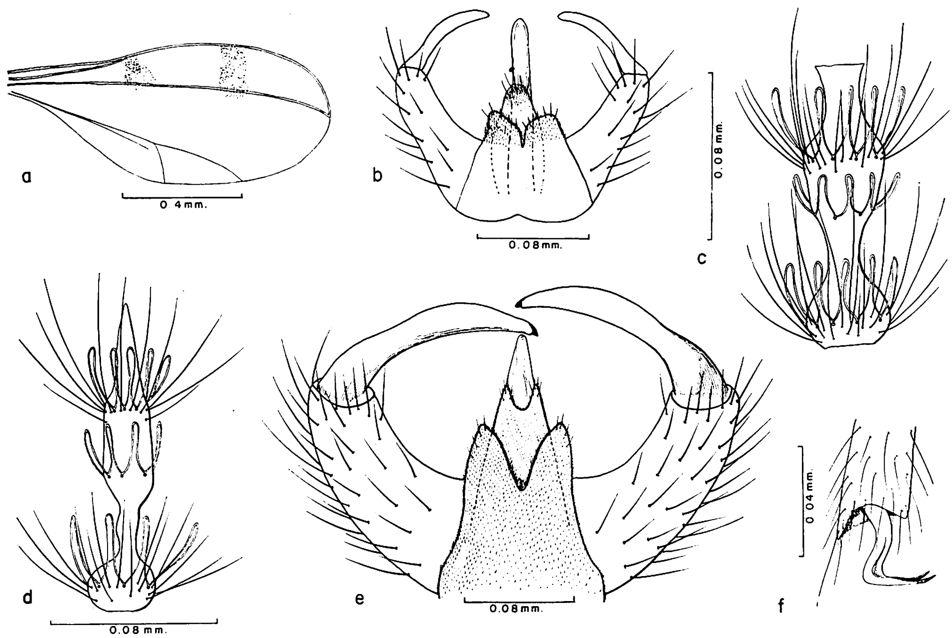

Figure 105—*Parallelodiplosis bimaculata* n.sp.: **a,** wing; **b,** male genitalia, dorsal view. *P. cattleyae* (Molliard): **c,** fifth antennal segment of male; **d,** apical antennal segment of male; **e,** male genitalia, dorsal view; **f,** tarsal claw. (Drawn from cotype.)

Genus **PHAENOBREMIA** Kieffer

Phaenobremia Kieffer, 1912, Neue Gallmücken-Gattungen, Bitsch, p. 1; Marcellia, 1912, 11:10.

Aphidoletes Felt, 1918, N. Y. State Mus. Bull. 202:133. *Nec* Kieffer, 1904, Ann. Soc. Sci. Brux. 28:385.

This fits in the group of genera which have three whorls of circumfila on each antennal segment; the palpi 4-segmented; and the claws of the anterior legs toothed, and those of the posterior legs simple. It is characterized by having one or more of the circumfila greatly extended into elongate bows or loops, 5 to 10 times longer than the antennal node and extending at approximately right angles to it (fig. 106a). Also the third and fourth antennal segments are fused together in the male; the ventral plate of the male genitalia is elongate, subcordate apically (fig. 106c); and the empodium is nearly equal in length to the tarsal claws.

Type of genus: *Phaenobremia urticariae* (Kieffer).

Phaenobremia meridionalis (Felt) (figs. 106a–d).
Aphidoletes meridionalis Felt, 1908, Bul. N. Y. State Mus. 124:397.

Oahu, Hawaii, and Kauai; probably also on other islands.

Immigrant. Europe and North America (type locality: Washington, D. C.).

Hosts: Evidently a general aphid feeder; in Hawaii, however, it has been taken only in association with the sugarcane aphis, *Aphis sacchari* Zehnter; the *Sonchus* aphid, *Amphorphora sonchi* (Oestlund); the cabbage aphid, *Brevicoryne brassicae* (Linnaeus); and the corn aphid, *Aphis maidis* Fitch.

First reported in Hawaii by Osborn in 1919 (1920:329) as an itonidid fly "bred from larvae associated with and feeding upon the sugar cane aphis at Waipio, Oahu." It was first identified by Dr. H. F. Barnes, of the Rothamsted Experiment Station, Harpenden, England, and reported by Williams (1931a:372). It has recently been reared from *Brevicoryne brassicae* and *Aphis maidis* at Waipio, Oahu, July, 1956 and 1957 (J. W. Beardsley) and probably feeds on several different aphids in the Islands. Specimens from Waipa, Kauai, September 28, 1937, are labeled "ex rice plant infested with borer and aphis" (O. H. Swezey).

At least in other areas, this is a general aphid feeder. It has been recorded feeding on 22 different species of aphids in the United States and Canada. Davis (1916) concluded that in certain cases it acts as a control of some aphids, e.g., *Aphis gossypii*.

Type in the U.S. National Museum.

On the Mainland the entire life cycle takes 15 to 29 days and there are continuous generations through the summer months. The adults live about 14 days. The larvae usually suck the body fluids from the aphids through one of the articulations of the legs—the articulation between the tibia and femur seems to be the favorite point of attack. Webster and Phillip (1912) stated that the larvae can suck a small aphid dry in a few minutes, and a full-grown aphid in 13 to 30 minutes. The aphids are not always sucked dry but usually are fed upon just until dead.

In Hawaii the species is readily distinguished by the generic characters given above. The very elongate loops of circumfila on the antennae make the males

easy to recognize *in situ*. The species is predominantly yellow, faintly tinged with brown, scutellum bright yellow. Thorax and abdomen with numerous rather long yellow hairs. Legs all yellow, anterior claws toothed, others simple. Wings gray, vein R_{4+5} curved downward, entering the margin distinctly below the apex. Media absent, Cu forked (fig. 106b). The stems of the flagellar segments of the male are rather slender, the basal stem of the fifth segment is two to two and one-half times longer than wide, the apical stem is four or more times longer than wide and is equal to slightly longer than the distal node (fig. 106a). The male dististyli are slender, slightly curved and nearly parallel sided. The dorsal plate is deeply cleft in the middle of the hind margin with two obtuse lobes. The ventral plate is enlarged and cordate apically, the enlarged portion is densely pubescent; the ventral plate extends three-fourths the length of the aedeagus measured from the base of the sternum (fig. 106c).

Length: body, 1.5 mm.; wings, 2.0 mm.

The flagellar segments of the female antennae are cylindrical, the nodes are about three times longer than wide with short stems at apex of each segment; the stems are about one-fourth as long as the nodes (fig. 106d). The ovipositor is short and the lobes are nearly as wide as long.

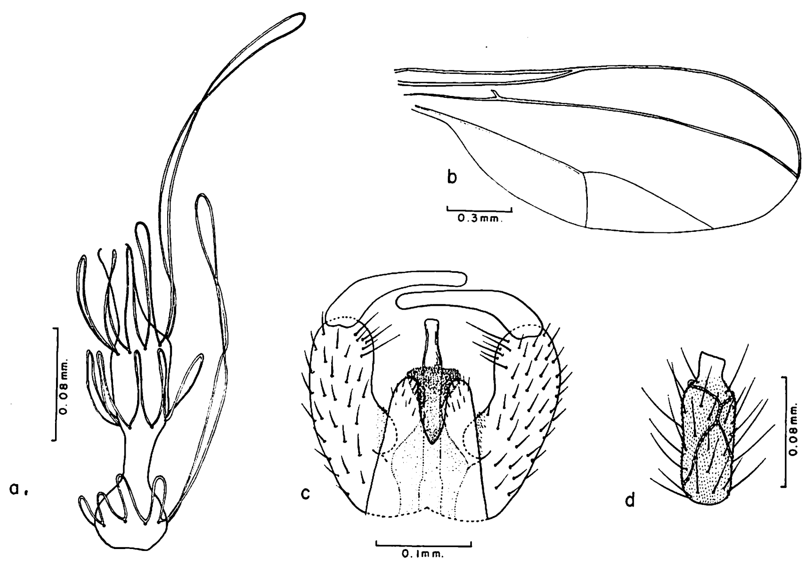

Figure 106—*Phaenobremia meridionalis* (Felt): **a,** fifth antennal segment of male; **b,** wing; **c.** male genitalia, dorsal view; **d,** fifth antennal segment of female.

Genus **TRISOPSIS** Kieffer

Trisopsis Kieffer, 1912, Boll. Lab. Zool. Portici 6:171.

A very distictive genus recognized by having the eyes divided into three groups of facets, a large group on upper portion of head and one on each side (fig. 107b); also the palpi are 3-segmented; vein Cu is simple; the claws are simple on all legs; and the basistyli are without basall obes. *Triommata* Barnes (1931:205) is the only other cecidomyiid in the literature with the eyes completely divided into three parts, and, according to Barnes, the two genera are phylogenetically closely related. *Triommata* differs from *Trisopsis* by having the palpi 4-segmented, the cubitus forked, the claws of front legs toothed, and the basal lobe of the basistylus spinose. The radial sector is rather well developed in the species at hand.

There are seven known species: *T. oleae* Kieffer, and *T. allaudi* Kieffer, from Africa (the former reared from fruits of *Olea verrucosa*); *T. bifida* Brèthes, from Argentina; *T. hyperici* Tavares, from Spain (described from females reared from galls of *Geocrypta hypericina* Tavares); *T. hibisci* Felt, from Louisiana (reared from seed pods of hibiscus); *T. tyroglyphi* Barnes, from Russia (predator on *Tyroglyphus farinae* (Deg.) mites); and *T. travancoricus* Nayar, from India (taken in light trap). Barnes says probably all species of *Trisopsis* are predaceous.

Just one species has been taken in Hawaii.

Type of genus: *Trisopsis oleae* Kieffer.

Trisopsis oleae Kieffer? (figs. 107a–d).
Trisopsis oleae Kieffer, 1912, Boll. Lab. Zool. Portici 6:171–172.

Oahu. Reared from native scales on Mt. Tantalus and taken at lights at Ewa and on window at Honolulu.

Immigrant. South Africa (type locality: Wellington). Type probably not in existence. Kieffer apparently did not designate a type.

Host: Predator on *Pedronia hawaiiensis* Ferris on *Dicranopteris linearis* (Burmann) on Mt. Tantalus. In the original Kieffer says: "Les larves de ce remarquable Diptère vivent dans les fruits d'*Olea verrucosa*." It seems probable that the specimens Professor Silvestri sent to Kieffer were preying on scales on the olive and were not actually infesting the fruit.

I see no satisfactory way to separate the specimens from Hawaii from *oleae*. It has not been possible to make comparisons with specimens from South Africa, but ours seem to fit the original description and figures in all details. I also can find no way of separating *T. travancoricus* Nayar, from Southern India, from *oleae*. Nayar said that *travancoricus* differs from *oleae* "in the comparatively smaller size of the body in both sexes; the absence of a conspicuous conical prominence on the vertex; the third vein reaching the wing margin at the apex; and the terminal clasp segment with deeply bifid apex." I suspect that Nayar did not have enough material to work with (one male and one female) and that the conical prominence is present (as it is on the Hawaiian specimens). I also suspect that the third vein (cubital) of *oleae* does extend to the margin (it is faint and difficult to see), although it was not so shown on the original figure. The slightly smaller size—0.7–0.8 mm. long for *travancoricus* and 0.8–1.0 mm. for *oleae*—is of no

significance. Nayar's "deeply bifid apex" of the clasper is obviously due to crushing under the cover slip. If our species from Hawaii is *oleae*, I think it probable that *travancoricus* is a synonym of that species.

A very tiny, predominantly pale, reddish yellow species with body, wings, and legs densely dark haired. The eyes and head are as in figure 107b. The mesonotum is discolored with brown, arranged indistinctly into three vittae. Legs, antennae, palpi, and genitalia yellow. Antennae 14-segmented, the stems of the flagellar segments of the male are two to three times longer than wide and about equal in length to the nodes. The loops of the distal circumfilum of each segment is about equal in length to the distal stem (fig. 107a). Apical enlargement of last segment cylindrical, two times longer than wide, and two times longer than basal node of last segment (fig. 107a). Third and fourth antennal segments fused. Palpi 3-segmented. Wings hyaline. Rs distinct; very short and vertical in position. R_{4+5} straight, ending at or slightly before wing apex. Cu simple (fig. 107c). Legs slender, hairy; claws simple on all legs; empodium nearly as long as claws. The basistyli of the male genitalia are rather straight sided and not lobed. The dististyli are simple, slightly curved on inner margin, and about two-thirds as long as basistyli. The dorsal plate has a deep, narrow cleft in middle of hind margin extending nearly to base. The ventral plate is slightly longer than dorsal, rounded at apex, not lobed. Aedeagus long and slender, extending nearly to apices of dististyli (fig. 107d).

The female is much like the male, but the flagellar segments of the antennae each have but one node which is about two times longer than wide, nearly two times longer than the stem, and each has two circumfila consisting of a slightly elevated thread girdling the segment; the nodes are very slightly compressed medianly.

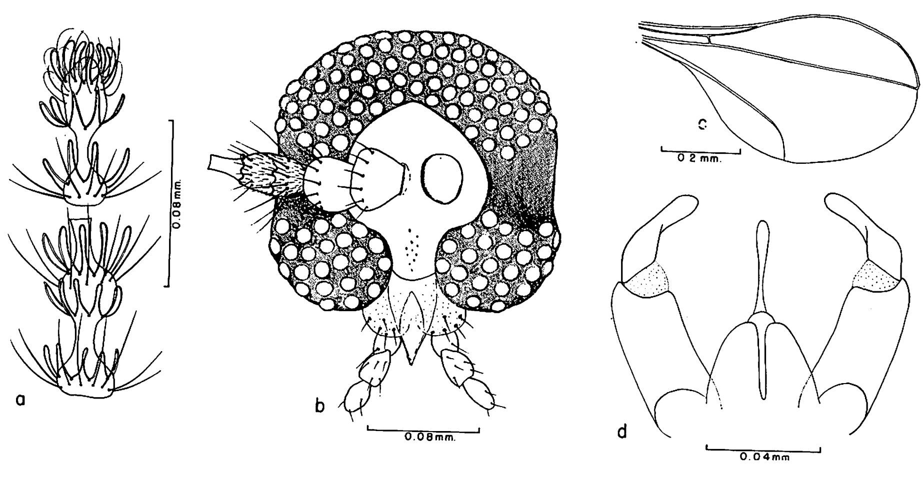

Figure 107—*Trisopsis oleae* Kieffer: **a,** fifth and apical antennal segments of male; **b,** head of female, front view; **c,** wing; **d,** male genitalia, dorsal view.

Length: body, 0.6-0.8 mm.

The larvae are light red to pink and prey upon the *Pedronia* scales on the false staghorn fern.

Suborder BRACHYCERA Macquart

Brachocera Macquart, 1834, Suites a Buffon. Hist. Nat., Dipt. 1:183.
Brachycera Zetterstedt, 1842, Dipt. Scandinaviae 1:1.
For more complete synonymy see Handlirsch, in Schröder (1925:975).

The suborder Brachycera as used in this study includes those flies whose adults escape from the puparium through a T-shaped opening and which lack a frontal lunule. The antennae are short (compared to those of most Nematocera) and in the Hawaiian species consist of but three distinctly articulated segments and the third has a well-developed style or arista (usually apical or subapical) in all except the Scenopinidae (fig. 115c). In the Stratiomyidae the third section of the antenna is obviously compound, consisting of five to eight closely compacted segments so the flagellum appears annulated (fig. 108b) but not distinclty segmented. The palpi are porrect and usually one- or two-jointed. The head is devoid of bristles except in Empididae.

But five families of Brachycera occur in Hawaii: Stratiomyidae, Bombyliidae, Scenopinidae, Empididae, and Dolichopodidae. Apparently only the latter two contain endemic species. Representatives of these families are easily recognized by their wing venation as well as by other details.

The Dolichopodidae are to be treated in the succeeding volume of this series.

Family STRATIOMYIDAE Latreille
Soldier Flies

Stratiomydae Latreille, 1802, Hist. Nat. Gen. des Crust. et des Ins. Paris 3:445.
Stratiomydes Leach, 1815, in Brewster's, Edinburgh Encyclopaedia 9:161.
Stratiomydides Billberg, 1820, Enum. Ins. in Mus. Billberg, Stockholm, Gadel 4:115.
Stratiomites Newman, 1834, Ent. Mag. 2:394.
Stratiomidae Westwood, 1840, Intro. Modern Class. Ins. 2:531.
Stratiomyidae Loew, 1860, Dipt. Fauna Südafrik: VII, 1.
Stratiomyiidae Comstock, J. H., and Comstock, A. B., 1893, Man. Study Ins: 418, 455.
For a more complete list of the synonyms under the family name see Handlirsch, in Schröder (1925:978). Also see Opinion 442, Zoological Commission (1957: 124).

The name has been derived from the Greek stratiotes, a soldier, plus myia, a fly; referring to the conspicuous bright-colored markings of the adults. The family name Stratiomyidae is based upon the original generic name *Stratiomys* Geoffrey, 1762, and not the emended "*Stratiomyia*" of authors. The family name has commonly been misspelled "Stratiomyiidae."

Medium to rather large flies; the largest (in length) fly in our fauna belongs in this family. These flies are characterized by their distinctive wing venation and by the structure of the antenna. In our species the wings have a well-developed discal cell (cell 1st M_2) with three to four veins radiating from it (fig. 108c). The third antennal section (flagellum) is annulated (most workers now consider this to be made up of six to eight compact segments), usually with an apical or subapical arista or style, apparently modified from the tenth antennal segment. The flagellum varies in shape from oval with a hair-like arista to elongate with a thickened, rather flat, arista. They are sparsely haired flies with no bristles but often with strong spines on the margin of the scutellum (fig. 108a).

The larvae of our species are probably all terrestrial or semi-aquatic. *Hermetia*, and probably *Cephalochrysa*, live in all kinds of decaying plant and animal materials. *Evaza* and *Neoexaireta* breed under decaying bark of trees and in rotting wood in the forests. Some species, at least in other areas, are considered predaceous. The larvae are elongated, rather cylindrical, or some may be somewhat flattened dorsoventrally; they are typically broad posteriorly and tapered toward the small narrow head. The integument is tough and leathery and usually dark colored.

The adults are found visiting flowers, feeding upon nectar and pollen, or are found around their breeding habitats, in vegetation.

Five species of stratiomyids are known from the Hawaiian Islands. These belong in five different genera, which in turn represent five distinct subfamilies; this is a remarkable representation of the nine subfamilies, usually recognized for the entire world. With the possible exception of *Hermetia illucens* (Linnaeus), these have probably all been imported from the west and the southwest Pacific area. The family is not known to be of economic importance except that *Hermetia illucens* has on some occasions in other areas been associated with cases of intestinal myiasis in humans.

Key to Genera and Species of Hawaiian Stratiomyidae

1. Scutellum with four strong spines on its margin (fig. 111a)....2

   Scutellum without spines................................3

2. Third section of antenna (flagellum) short and thick, as wide as long, and bearing a long subapical, dorsal arista (fig. 111c). Vein M_3 lacking (only three veins meet cell 1st M_2); venation as in figure 111b. Legs all yellow. Abdomen chiefly yellow. Length of body about 6.0 mm...........
   ....**Evaza javanensis** de Meijere.

   Third section of antenna elongate and tapered to the apex, with no arista (fig. 108b). Vein M_3 present (four veins arising from cell 1st M_2); venation as in figure 108c. Legs extensively black. Abdomen entirely blue-black. Body

12.0 mm. or more in length. . . . . **Neoexaireta spinigera** (Wiedemann).

3. The apical portion of the antenna is modified into a broad, flat style about equal in length to the third section (fig. 110a). The second abdominal segment with a pair of translucent spots. The wings are brown, the venation as in figure 110b. Large species, body 15.0–18.0 mm. long. . . . . **Hermetia illucens** (Linnaeus).
   Not as above. Species 4.6–9.5 mm. 4

4. Flagellum of antenna oval, with an elongate terminal arista (longer than remainder of antenna) (fig. 112a). Costa extending nearly to apex of wing; vein R_4 situated about half way between R_{2+3} and the apex of R_5; cell Cu closed near wing margin (fig. 112b). Chiefly metallic blue or blue-green species. . . . . **Cephalochrysa hovas** (Bigot).
   Tip portion of flagellum modified into a short style which terminates in a seta (fig. 109b). Costa ending well before wing apex; vein R_4 situated near apex of R_5 and cell Cu with a distinct petiole (fig. 109a). Chiefly black species. . . . . **Brachycara latifrons** James, n. sp.

Subfamily BERIDINAE Westwood

Beridae Westwood, 1840, Intro. Modern Class. Ins., London 2:533.
Beridina Rondani, 1856, Dipt. Ital., Parma 1:173.
Berinae Schiner, 1862, Fauna Austriaca 1:XLV.
Beridinae Williston, 1896, Manual of N. A. Dipt. 2nd. ed. p. 46.
Beridiinae Kertesz, 1908, Cat. Dipt. 2:122.
Actininae Enderlein, 1913, Zool. Anz. 42:534.
Metoponiini Enderlein, 1921, Mitt. Zool. Mus. Berlin 10:180.

Members of this subfamily are differentiated from other stratiomyids by having seven visible segments in the abdomen; by lacking a distinct style or arista on the antenna; by having the media four-branched with all of the veins arising from cell 1st M_2 (fig. 108c); by having four or more strong spines on the hind margin of the scutellum; and by having the palpi 3-segmented.

The genus *Neoexaireta* Osten Sacken is the only representative in Hawaii.

Genus **NEOEXAIRETA** Osten Sacken

Neoexaireta Osten Sacken, 1878, Smithsonian Misc. Coll. 270:44. A change of name for *Exaireta* Schiner, 1867, Verh. Zool.-Bot. Ges. Wien 17:309; *nec Exaereta* Huebner, 1820, Verz. Bekannt. Schmett. 13:200.

This genus is distinguished by the subfamily characters given above, but evidently fits closest to *Actina* Meigen. However, it differs by having four spines

on margin of scutellum, not six to eight; by having a bare area extending from wing base over each pteropleuron to the hypopleuron; and by having the metonotum pilose, rather than having the pteropleuron haired and the metonotum not pilose as in *Actina*. Dr. G. H. Hardy (1932:51) also regarded the small ventral tubercle near the apex of the hind femur as distinctive for separating *Neoexaireta*.

Type of genus: *Xylophagus spiniger* Wiedemann.

Noexaireta spinigera (Wiedemann) (figs. 108a–e).

Xylophagus spiniger Wiedemann, 1830, Auss. Zweifl. Ins. 2:618.

Beris servillei Macquart, 1838, Dipt. Exot. 1:172.

Diphysa spinigera Walker, 1854, List Dipt. Ins. British Museum, Suppl. 1:7.

Neoexaireta spinigera (Wiedemann) Osten Sacken, 1878, Smithsonian Misc. Coll. 270:44.

Found rather commonly on all the main islands. Widemann apparently did not indicate a type. Dr. E. M. Hering has reported to me that the type is present in the Zoologisches Museum der Humboldt Universitat zu Berlin.

Immigrant. Australasian region.

First recorded in Hawaii by Grimshaw (1902:79). Perkins (1913:CLXXXII)

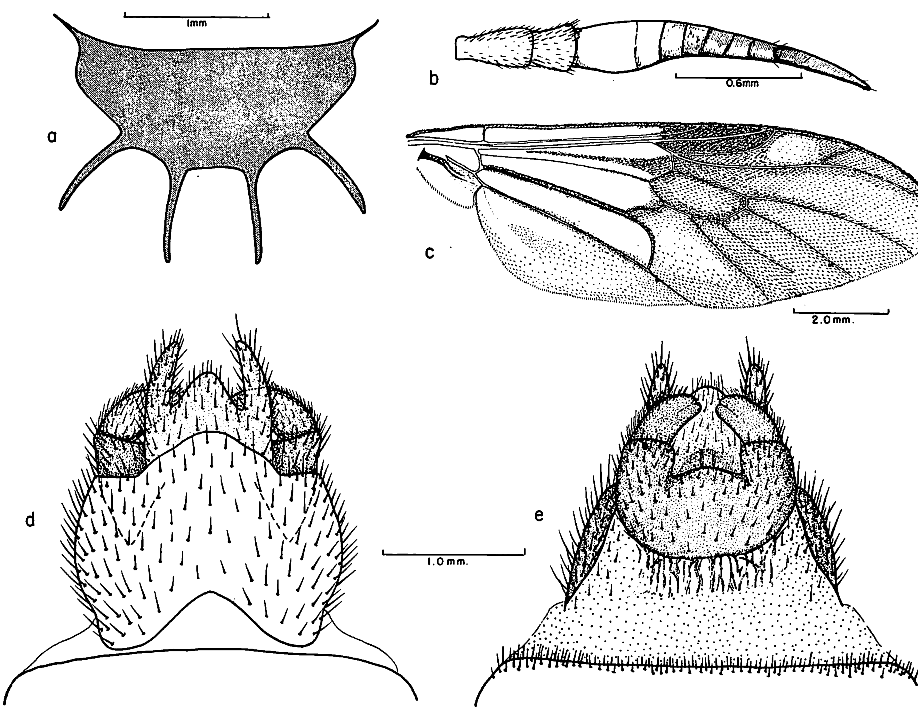

Figure 108—*Neoexaireta spiniger* (Wiedemann): **a,** scutellum; **b,** antenna; **c,** wing; **d,** male genitalia, dorsal view; **e,** male genitalia, ventral view.

says that it was not observed here in 1897 but was common around Honolulu in 1900.

This is a moderately large, black species readily differentiated from other Hawaiian stratiomyids by the blue-black coloration; by the four strong spines on the scutellum (fig. 108a); by the elongate tapered antennal flagellum (fig. 108b); by the chiefly black femora, with pale yellow bases; and by the wing maculation and coloration as shown in figure 108c. For details of the genitalia refer to figures 108d and 108e.

Length: body, 10.0–16.0 mm.; wings, 8.0–13.0 mm.

The adults are often seen hovering over rotting vegetation, and the larvae probably breed in a variety of different types of humus materials. The larvae (Williams, 1931b:280) have been found under dead bark and in rotting sugarcane. Illingworth (1929a:252) observed this fly laying its eggs in wounds in the trunks of papaya trees. According to Bryan (1934:470), these flies are preyed upon by a crabronid wasp.

Subfamily CLITELLARIINAE Lundbeck

Clitellariinae Lundbeck, 1907, Dipt. Danica 1:18.

Potamidinae Brues, Melander and Carpenter, 1954, Bul. Mus. Comp. Zool. 108:327.

The subfamily name is based upon *Clitellaria* Meigen (1803). This is treated as a synonym of *Potamida* Meigen (1800) by Lindner (1938:150). James (in correspondence) indicates that *Clitellaria* may be "a synonym of either *Potamida* or *Adoxomyia*, depending on whether the type of the subfamily is considered to be the true *Clitellaria* or *Clitellaria* of the older authors but not Meigen." In accordance with the Copenhagen Decisions (1953:36, par. 54 (1) (a)) a family group name may be based upon a synonym and Clitellariinae is apparently the preferred name.

The members of this subfamily are differentiated by having not more than two spines on the scutellum (scutellum unspined in *Brachycara*), all four branches of media arising from cell 1st M_2 (discal), the last antennal segment styliform or undifferentiated, and the abdomen not elongated. They are mostly small black flies with white, yellow, or green markings.

Only the genus *Brachycara* Thomson occurs in Hawaii.

Genus **BRACHYCARA** Thomson

(The discussion on this genus and the description of the new species was written by Dr. M. T. James.)

Brachycara Thomson, 1868, Eugenies Resa, Diptera, p. 460.

Euryneurasoma Johnson, 1913, Bul. Amer. Mus. Nat. Hist., 32:51. Type, *E. slossonae* Johnson, l.c. **New synonymy.**

Neurota Curran, 1931, Amer. Mus. Nov. 456, p. 2. Type, *Sargus bicolor* Wiedemann, Curran 1931 (misidentification), not Wiedemann 1830. **New synonymy.**

Three species in this genus are previously known; two of these, namely *B. slossonae* (Johnson) and *B. maculata* (James) (1953, Amer. Mus. Nov. 1613, p. 2), occur in the West Indies and one, *B. ventralis* Thomson, occurs from the Andaman Islands (type locality) westward to the Seychelles and eastward, through the East Indies, to the Caroline Islands. It is interesting to note that the known distribution of the genus is entirely insular.

It is difficult to find close relatives among the other known Clitellariinae. The main diagnostic characters are as follows: eyes either bare or hairy; face slightly receding in lateral profile; antennae distinctly shorter than head, the first segment but little longer than its maximum width, the flagellum 6-segmented, its basal complex oval, the terminal two segments forming a distinct style, the last segment distinctly longer than wide, terminating in a seta, the preceding one very short. Proboscis very short. Thorax without lateral spines; scutellum unspined. Abdomen oval, mostly parallel-sided, somewhat broader than the thorax, not inflated. Vein Cu_1 forming a segment of the lower part of the discal cell which is almost as long as that formed by the following part of vein M_3; radial sector bent to a distinct angle at its junction with crossvein r–m.

Because of the variation in eye pilosity, *Brachycara* cannot be separated from *Lasiopa* on this basis; the shorter face and the differences in wing venation will serve best to separate the two genera.

Type of genus: *Brachycara ventralis* Thomson.

Brachycara latifrons James, **new species** (figs. 109a–e).

Readily distinguishable from the other known species of *Brachycara* by the broad frons of the female, the black (rather than ivory to white) lower frontal calluses, the predominantly black femora, and the distinctive male genitalia, particularly the digitate extensions of the ventral plates (fig. 109d). The venation compares with that of *maculata* and differs from that of *ventralis* and *slossonae* in the upward bowing of Rs beyond crossvein r–m and in the tendency for vein R_4 to vanish.

MALE. Eyes subcontiguous, distinctly hairy. Face and frons black, the latter without evidence of pale spots. Cheeks broad; the distance from the oral margin to the nearest part of the eye equal to that from the clypeus (apex of oral margin) to the base of the antennae, each being about 40 micrometer units (60 = 1 mm.). Antenna (fig. 109b) shorter than head (29 and 40 micrometer units respectively); ratio of scape, pedicel, and six flagellar segments 5: 6: 5: 2: 2: 5: 1: 3; scape and pedicel castaneous, flagellum black. Face white-pilose, though not densely silvery as in *ventralis;* palpi short, the terminal segment inflated.

Thorax black, the notopleural line only very narrowly pale; pile and hairs black, some pale appressed pile appearing on the mesonotum and pectus under certain lights. Coxae, trochanters, femora except apices, and tibiae except bases and apices black; legs otherwise yellowish. Wings hyaline, veins blackish; stigma blackish-infumated; Rs distinctly bowed forward, ending far beyond the wing apex (fig. 109a). Measurements in micrometer units: r–m to end of Rs, 45; end

of Rs to wing apex, 40; segment of costal margin between apex of R_1 and R_{2+3}, 15; same between R_{2+3} and R_4, 20; same, between R_4 and R_5, 5. Halteres white.

Abdomen reddish yellow, somewhat darkened at base dorsally and ventrally. Genitalia (fig. 109e) (from holotype; missing in paratype) yellow; ventral plates prolonged into two approximated digitate structures, between the styles, which extend beyond their bases almost the length of the styles; styles narrow, elongated, about five times as long as their maximum (basal) width, narrowing medially and becoming somewhat enlarged again toward their apices (fig. 109d); aedeagus three-pronged (fig. 109c), all processes slender, the lateral ones slightly and gradually diverging from the median one.

Length: 5.0–6.0 mm.

FEMALE. Frons broad, as broad as the head length and one-half as wide as the head. Eyes with shorter, though distinct, pile. Mesonotum and pleura of thorax with abundant appressed whitish pile. Abdomen dark castaneous, tending to blackish. Otherwise, except sexually, as described for the male.

Holotype male, allotype female: Laysan Island, April 3, 1923 (D. T. Fullaway). Paratypes: 2 males, 1 female, same data as type; 1 male, 1 female, Laysan Island (G. P. Wilder); 1 female, Honolulu, Hawaii, "12-6-55" (C. R. Joyce). Some of the specimens collected by Fullaway were labeled "near lagoon" and were evidently reared; 2 pupae are present, same data as type.

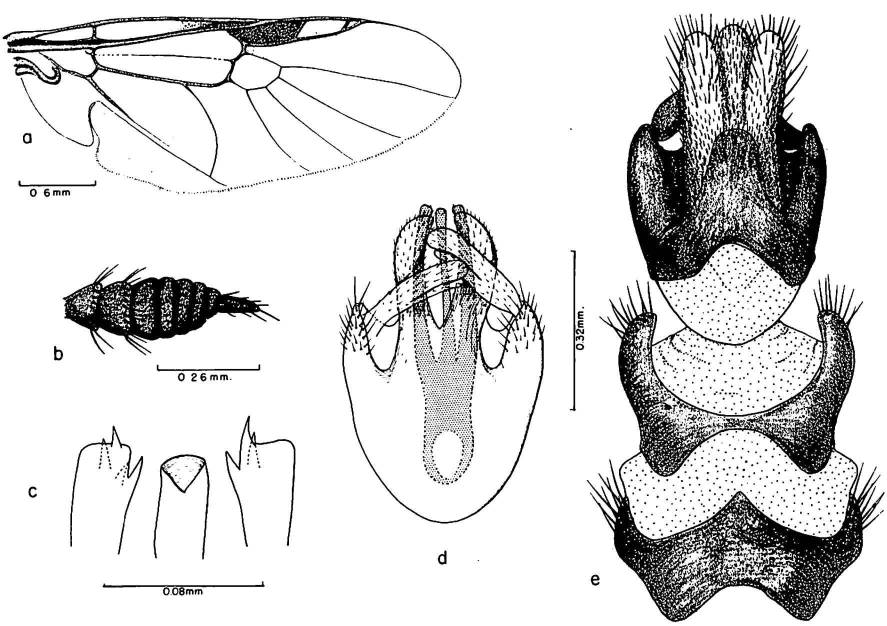

Figure 109—*Brachycara latifrons* James n.sp.: **a,** wing; **b,** antenna; **c,** tip of aedeagus; **d,** male genitalia, ventral view; **e,** apical portion of male abdomen, dorsal view.

Variation. As a result of a slightly teneral condition or aging, the Fullaway specimens appear more extensively castaneous in the black areas than the above description would indicate. These specimens have been chosen as the holotype and allotype, however, because of the preservation of the male genitalia.

Type and allotype in the B. P. Bishop Museum. The paratypes have been deposited in the following collections: U.S. National Museum, M. T. James, and the University of Hawaii.

Subfamily HERMETIINAE Loew

Hermetiinen Loew, 1860, Die Dipt. Fauna Südafrik. 1:3.
Hermetiinae Brauer, 1880, Zweifl. des Kaiserlichen Mus. Wien 1:113.

Members of this subfamily are characterized by having only five visible abdominal segments; by having all four branches of M arising from cell 1st M_2; by the scutellum lacking spines, and by having the last section of antenna (tenth segment?) flat and broad, ribbon-like, and the preceding portion of flagellum with a distinct groove on inner surface.

Only one genus, *Hermetia* Latreille, occurs in Hawaii.

Genus **HERMETIA** Latreille

Hermetia Latreille, 1804, Hist. Nat. des Crust. et des Ins. 14:38.

Members of this genus are differentiated by the subfamily characters given above. Apparently the flattened strap-like apical section of the antenna will distinguish it from all other genera.

Type of genus: *Musca illucens* Linnaeus.

Hermetia illucens (Linnaeus) (figs. 110a–d).

Musca illucens Linnaeus, 1758, Syst. Nat. ed. 10, vol. 1:589.
Hermetia illucens (Linnaeus) Latreille, 1804, Hist. Nat. des Crust. et des Ins. 14:338.

Common on all of the Islands.

Immigrant. Widespread throughout the Nearctic and Neotropical Regions. In the Pacific, besides Hawaii, it has been recorded from Samoa, Guadalcanal, and Bougainville. In the Palaearctic Region it has apparently been recorded only from Malta (Lindner, 1938:202) and from Italy (Venturi, 1956:57).

The type has probably been lost.

H. illucens was first reported in Hawaii by Williams (1933:232) and was first observed in 1930 in the sugarcane fields of the Hilo Sugar Company. It breeds in tremendous numbers in the filter-press mud as well as in all other types of decaying organic matter. In some other parts of the world a number of cases of intestinal myiasis in man have been caused by this species. The large vigorous larvae have caused severe gastro-intestinal disturbances in cases where they have been accidently injested with contaminated food.

This well-known species is readily differentiated from other stratiomyids by its

large size; by the two translucent spots on the second tergum of the abdomen and the single large, clear spot on the second sternum; as well as by the details of the antennae (fig. 110a), the wings (fig. 110b), and the male genitalia (figs. 110c, 110d).

Length: body, 15.0–18.0 mm.; wings, 12.0–13.0 mm.

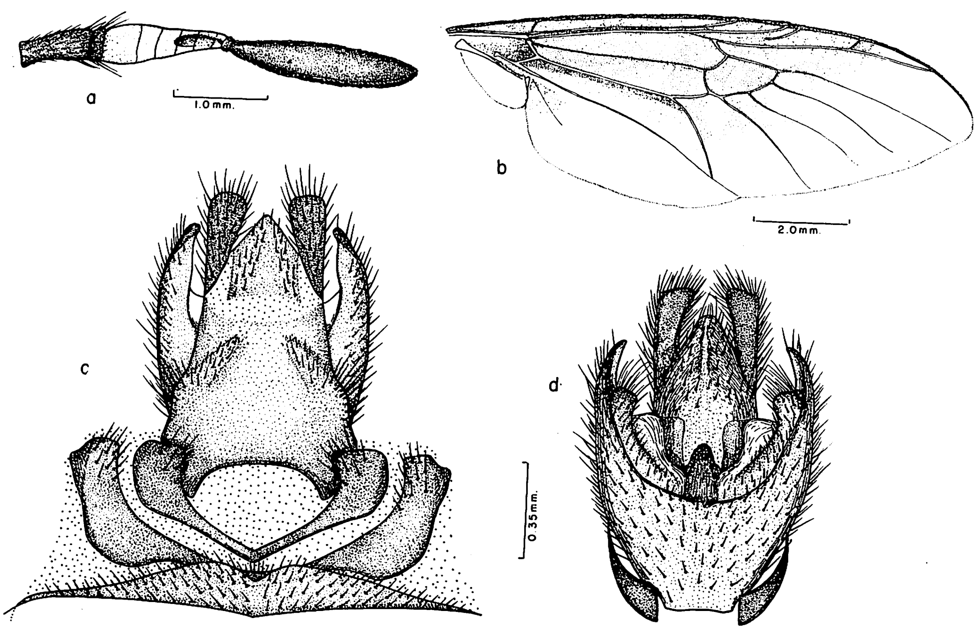

Figure 110—*Hermetia illucens* (Linnaeus): **a,** antenna; **b,** wing; **c,** male genitalia, dorsal view; **d,** male genitalia, ventral view.

Subfamily PACHYGASTRINAE Loew

Pachigastrina Loew, 1856, Oefvers. vet. Akad. Förh. 13:264.
Pachygastrinae Schiner, 1862, Fauna Austriaca 1:XLV.

Members of this subfamily are characterized by having only five visible abdominal segments; by having only three branches in the media (fig. 111b). They also have the antennal flagellum oval with four to five annules, evidently composed of six very compact segments, with the last modified into a long style; the basal two-thirds of this is bristle-like and pubescent, the apical portion is hair-like and bare (fig. 111c).

The genus *Evaza* Walker is the only representative in Hawaii.

Genus **EVAZA** Walker

Evaza Walker, 1857, Proc. Linn. Soc. Lond. 1:109.

Members of this genus are characterized (in Hawaii) by the subfamily characters given above, by the four strong spines at the apex of the scutellum (fig. 111a), and by specific characters given in the description and figures below.

Lindner (1938:202) keys *Evaza* as having six spines on the scutellum. According to James in correspondence, this is an error, since there are only four spines. In Brunetti's key (1923:47) Evaza runs near *Tinda* Walker and *Rosapha* Walker and is differentiated by having the third antennal segment short, subconical, and with an elongate arista. Dr. James (in correspondence) wrote: "In the Kertesz key to the genera of Pachygastrinae (1916:129), *Evaza* runs out easily on the basis of the elongated body, the origin of the second vein above or beyond r–m, and the simple aristate antenna."

Type of genus: *Evaza bipars* Walker.

Evaza javanensis de Meijere (figs. 111a–e).
Evaza javanensis de Meijere, 1911, Tidjschr. v. Ent. 54:274.

Oahu, Maui, Hawaii, Kauai, and probably on all of the main islands.

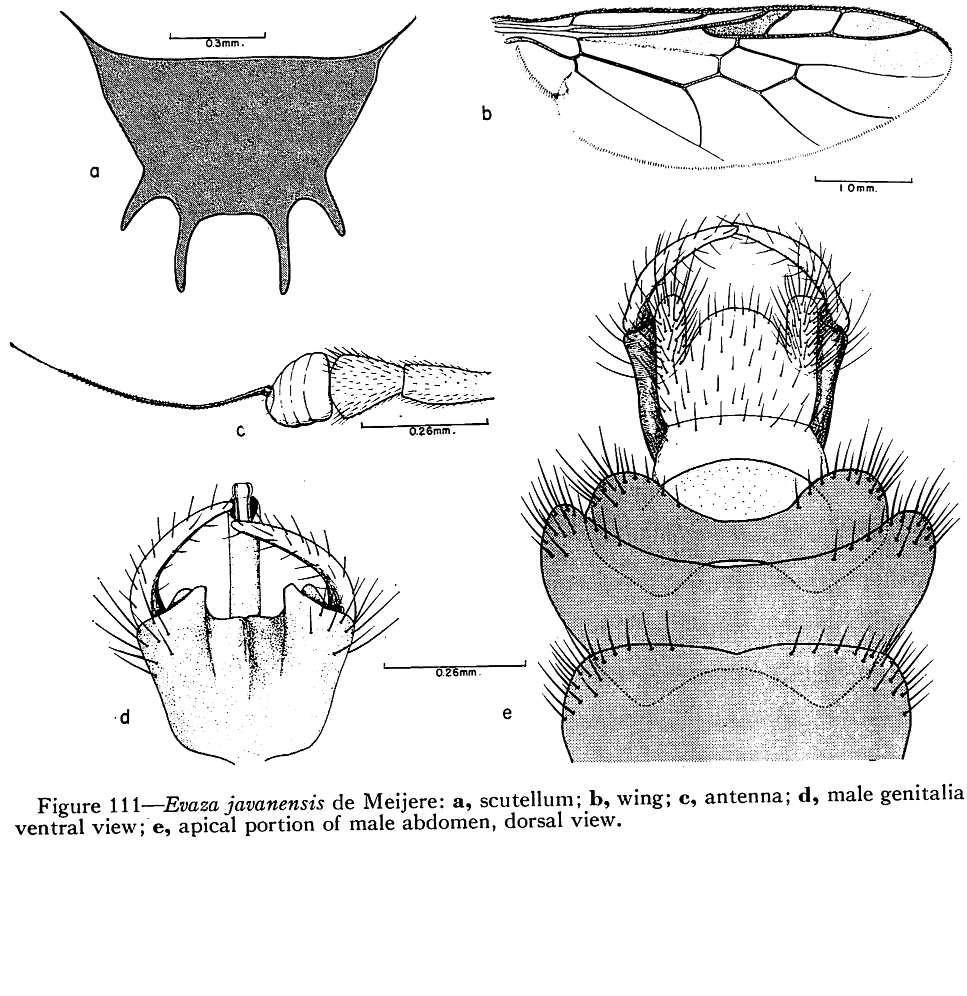

Figure 111—*Evaza javanensis* de Meijere: **a,** scutellum; **b,** wing; **c,** antenna; **d,** male genitalia, ventral view; **e,** apical portion of male abdomen, dorsal view.

Immigrant. Malaya and Indonesia.

Type in the Zoologisch Museum, Amsterdam.

This appears to be the species which Grimshaw (1902:79) recorded as a questionable genus and species "very near *Acanthina* Wied." Brunetti first determined it as *Evaza javanensis* de Meijere (Bryan 1924:349). Bryan (1934:407) said this species probably arrived in Hawaii about 1900. It has been listed in Hawaiian literature as *Evaza javanensis* Meigen; this is an error in the authority.

This is the smallest of the Hawaiian stratiomyids. It is recognized by its small size; by the all-yellow legs and antennae; by the short flagellum, with a dorso-apical arista (fig. 111c); by the yellowish colored central portion of the abdomen; by the wing maculation and venation (fig. 111b); and by the male genital characters (figs. 111d, 111e).

Length: body, 5.5–6.5 mm.; wings, 5.3–5.7 mm.; de Meijere said the body and wings measure 5 mm.

This species is usually taken in dense vegetation under trees. It probably breeds in plant humus.

Subfamily SARGINAE Loew

Chrysomyna Rondani, 1856 (in part), Dipt. Ital., Parma 1:167.
Sargina Loew, 1856, Oefvers. vet. Akad. Förh. 13:263.
Sarginae Schiner, 1862, Fauna Austriaca 1:XLV.
Rhaphiocerinae Brauer, 1880, Zweifl. des Kaiserlichen Mus. Wien 1:113.
Geosarginae Enderlein, 1914, Zool. Anz. 43:579.

Members of this subfamily are characterized by having five visible abdominal segments; by vein M_4 appearing to be connected with cell 1st M_2 by a crossvein (fig. 112b); by lacking spines on the scutellum; and by having a strong bristle-like terminal arista (modified apical segment) on the antenna (fig. 112a).

Only one genus, *Cephalochrysa* Kertesz, occurs in Hawaii.

Genus **CEPHALOCHRYSA** Kertesz

Cephalochrysa Kertesz, 1912, Trans. Linn. Soc. Lond. 15:99.
Isosargus James, 1936, Can. Ent. 67:273.

This genus has been treated as a synonym of *Microchrysa* Loew by some authors. Ricardo (1929:116) says Kertesz regarded *Cephalochrysa* as distinct from *Microchrysa* "owing to larger size, identity of colouring in the two sexes, the dark colour of the veins of the wings and the fact that the white band on the front reaches the eye on each side. Since all of these characters are present in *M. maxima* Bezzi, it would appear that Kertesz's genus should be sunk in *Microchrysa*." Dr. M. T. James treats these as distinct genera in his paper on the Stratiomyidae of the Solomon Islands (1948:198–199) and has stated in correspondence that he considers *Cephalochrysa* a valid genus. In a letter he said that *Cephalochrysa* may be distinguished from *Microchrysa* on the basis of the comparative width of the basal cells, the size of the discal cell, the comparative strength of the veins extending

from the discal cell, and the size of the insect (cf. James's keys 1935:269, 1948:189, and 1950:248–249).

The single representative of this genus in Hawaii is readily recognized by the characters given in the generic key above. It fits closest to *Hermetia* (of the Hawaiian species) but differs strikingly in the details of the antenna (fig. 112a), wing venation (fig. 112b), the male genital characters (figs. 112c, 112d) and the many other differences as brought out in the description of the species below.

Type of genus: *Microchrysa hovas* Bigot.

Cephlochrysa hovas (Bigot) (figs. 112a–d).

Microchrysa hovas Bigot, 1859, Ann. Soc. Ent. France (3) 7:133.

Widespread; apparently on all the islands.

Immigrant. South Asiatic and African regions. The type was from Madagascar.

Type in the private collection of J. E. Collin, Newmarket, England.

This was recorded in the Hawaiian literature as *Sargus* sp. by Howard (1901: 490), Grimshaw (1901:11), and Terry (1906:37). It was first determined as *Cephlochrysa hovas* by Brunetti (Bryan, 1927:369). Ricardo (1929:116), in com-

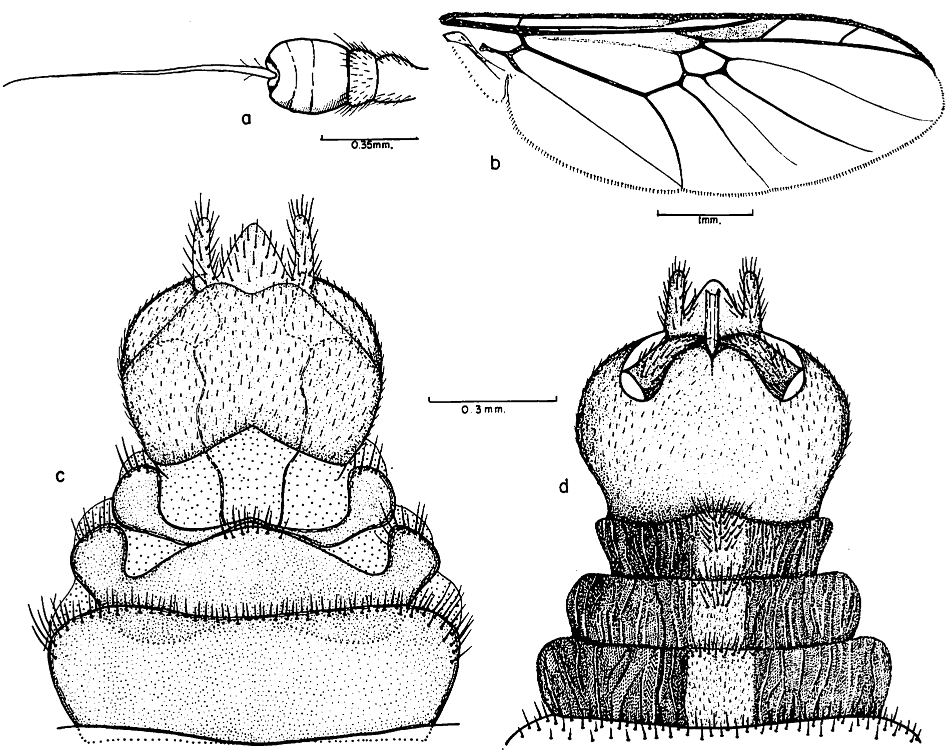

Figure 112—*Cephalochrysa hovas* (Bigot): **a,** antenna; **b,** wing; **c,** male abdomen, dorsal view; **d,** male abdomen, ventral view.

paring it with *Microchrysa maxima* Bezzi from Samoa, changed the genus to *Microchrysa*. It has been listed under this combination in most of the Hawaiian literature, but, as pointed out above, *Cephlochrysa* is a valid genus.

This species is readily differentiated from the other Hawaiian stratiomyids by its metallic-blue abdomen and blue-green mesonotum; by the short antennal flagellum and the apical style (fig. 112a); by the almost completely hyaline wings and distinctive venation (fig. 112b); and by the male genital characters (figs. 112c, 112d).

Length: body, 8.0–9.5 mm.; wings, 6.0–8.0 mm.

This species breeds in rotting vegetation.

Family BOMBYLIIDAE Latreille

Bee Flies

Bombylarii Latreille, 1802, Hist. Nat. Crust. et Ins. 3:427; Fallén, 1815, Dipt. Sveciae: Platypezinae et Bombylarii Sveciae, p. 8.
Bombylides Leach, 1815, In Brewster's, Edinburgh Encyclopaedia 9:162.
Bombylidae Samouelle, 1819, Entomologists Useful Compendium, 295.
Bombyliides Billberg, 1820, Enum. Ins. in Mus. Billberg, Stockholm, Gadel 4:117.
Bombiliites Newman, 1834, Ent. Mag. 2:389.
Bombyliadae Kirby, 1837, Fauna Boreali-Americana 4:312.
Bombyliidae Westwood, 1840, Intro. to Modern Class. Ins. London 2:542.
For other family name synonymy see Handlirsch, in Schröder (1925:989).

The name is derived from the Greek bombylios, an insect that hums or buzzes, a bumble bee; apparently from the resemblance of some species to bees.

This is a very large important family of flies, widely distributed throughout the world, and very common in continental areas, especially in tropical and subtropical regions. The immature stages are parasites and predators on larvae of various bees, wasps, cutworms, army worms and other caterpillars; upon the eggs of grasshoppers and beetles; and upon the pupae of tsetse flies.

Bombyliids are stout-bodied, rather small to moderately large flies; some are rather similar to bees in appearance and some genera are wasp mimics. They are related to the families Asilidae, Cyrtidae, and Therevidae, but the details of wing venation, shape of the head, antennae, and genitalia are very different. The bee flies have but four posterior cells in the wing, the head is globular, and the antennae are porrect, usually with a short style at apex of third segment. They are very attractive, beautifully marked, flies, the wings often pictured, and most species are very densely pilose, usually with colored scales forming a distinct pattern on the body.

The bee flies are extremely rapid fliers and often hover in the air, much as do the syrphids. Many species are attracted to flowers. The eggs of the bee fly are laid in the near vicinity of the host nest or egg sack. The larvae are hypermetamorphic; the first instar is very active and seeks out the host. The other instars are quiescent and remain attached to the host (or as with beetle and grasshopper

eggs they remain relatively stationary in the egg mass) slowly sucking it dry. The story as told by Fabre (1927) of the habits of *Anthrax trifasciata* Meigen, which preys upon the wall bee (*Chalicodoma muraria* Retzius) in France, is one of the classics of entomological literature.

Genus **ANTHRAX** Scopoli

Anthrax Scopoli, 1763, Ent. Carn., p. 358.
Argyramoeba Schiner, 1860, Wien Ent. Monatschr. 4:51.
Coquillettia Williston, 1896, Man. N. Amer. Dipt. 2nd ed., p. 65.
Chalcamoeba Sack, 1909, Abh. Senckenb. Ges. 30:510, 522.
Leucamoeba Sack, 1909, Abh. Senckenb. Ges. 30:510, 520.

Synonymy taken from Engel (1938a:420). Brunetti (1920:234) and Senior-White (1923:12) list many more generic names as synonyms; I cannot confirm these. The synonymy has evidently been badly confused in the literature. Scopoli's description of *Anthrax* was supposedly based on *Musca morio* Linnaeus (1758:590), but, as pointed out by Aldrich (1926:12), Scopoli obviously had before him *Musca anthrax* Schrank (1781:439). This had been described, without a name, by Linnaeus (1746:316) and later (1761:440) incorrectly combined with *Musca morio*, by Linnaeus. Two quite different concepts are apparently involved. The true *morio* Linnaeus (1758) lacks the tuft of hair at the apex of the antennal style (according to Aldrich) while *anthrax* Schrank and the species described by Linnaeus in 1746 possess this tuft. It seems apparent that the genus *Anthrax* should be based upon this latter concept. Brunetti (1920:177) treats *Anthrax* in the sense of *M. morio* Linnaeus, differing from *Argyramobea* Schiner by lacking the tuft of hairs at the tip of the style.

Spogostylum Macquart, based upon *S. mystaceum* Macquart (1840:331) from South America, has been considered a synonym by Aldrich (1926:12), Coquillet (1910:508), and others. This is considered a distinct genus by Engel (1938a:357), differentiated from *Anthrax* by having the third antennal segment spherical, not broader than the second, and vein R_3 (after Hennig, 1954:351, "R_4" of Engel) complete, not just partially developed.

Anthrax is distinguished from other genera of Bombyliidae by having vein R_3 arising just slightly before the r–m crossvein (in the Hawaiian species) and the radial sector rather long (distinctly longer than R_{4+5}) from the crossvein to the furcation (fig. 113a); by having R_3 present only as an appendix near base of R_4; also by having the third antennal segment broader than second and the antennal style separated from the third segment by a distinct suture and terminating in a clump of short hairs (fig. 113b).

Members of this genus live in the nests of various wasps, leafcutter and mason bees, and in egg cases of locusts. Fabre (1927) gave an interesting account of a European species (*Anthrax trifasciata* Meigen) which parasitizes a mason bee. The following is quoted from Colyer (1951:108–109), the account taken from the English translation of Fabre's *The Life of the Fly* (1927):

Eggs are laid on the ground near the nest of the host, a species of Mason-Bee, which seals the cell containing its grubs, just before they pupate, with a kind of mortar. The newly hatched *Anthrax* larvae are minute, active, hair-like creatures, which wander off and search for a tiny orifice in the mortar, through which to penetrate to the cell. In this condition they are able to subsist for long periods without food, as well they need, since gaining an entry is no easy task, even for so microscopic an organism. Once ensconced in the bee-cell, the larva does not necessarily begin feeding on its host immediately; the attack is made at a time when the bee-grub becomes quiescent, in preparation for the pupa-stage. At this point, the fly larva undergoes a transformation into a smooth, fat grub with a small sucker-mouth. It obtains its sustenance from the bee-pupa by applying this sucker-orifice to its skin and, without causing a lesion, withdraws, slowly but surely, the whole of the body-substance of its host. This process is so regulated that the early death and subsequent putrifaction of the host, with its attendant disaster for the parasite, is avoided; when the fly-larva is small, the withdrawal from the host is almost imperceptible; as it grows, the process speeds up; the host is ultimately sucked dry when the fly-larva is ready to pupate. Thus it does, perforce, inside the cell, being enclosed by an apparently impenetrable wall. The pupal stage has two phases; the first, or pre-pupal phase, is normal, the transformation from larva to fly taking place within a normal puparium; but now the problem of escape from the cell arises. In the case of the rightful occupant, exit would be effected with the aid of the powerful mouth-parts, but the parasite-fly has no such armament; so, another remarkable transformation takes place; the second-phase pupa develops strong spines on the head, in the form of a coronet and, with this as a ram, commences an onslaught upon the imprisoning wall. Assistance in this process is gained from the transverse rows of strong spines on the abdominal segments. Eventually the wall is breached, the pupa protrudes its anterior part and the adult fly emerges to freedom.

Just one species occurs in Hawaii. There are no other flies in our fauna with which this can be confused.

Type of genus: *Musca anthrax* Schrank (as *morio* Linnaeus).

Anthrax distigma Wiedemann (figs. 113a–c).
Anthrax distigma Wiedemann, 1828, Ausser. Zweifl. Ins. 1:309.

For synonymy under this species see Brunetti (1920:218).
Oahu.

Immigrant. Widespread throughout India, Burma, Japan, southeast Asia, and the southwest Pacific; recorded from Java, Sumatra, Moluccas, Celebes, Philippine Islands, New Guinea, New Caledonia, and "Willowmore, Kapland" (Zoologische Staatssammlung, Munich). According to Dr. Paramonov (in letter) it has not yet been recorded from Australia, "but must be, doubtlessly present here."

Type in the Naturhistorisches Museum, Wien.

First collected in May, 1954 (see Tuthill, 1955:381), on the slopes of Punchbowl, Honolulu. It has since been reported from numerous localities in Honolulu from Diamond Head to the B. P. Bishop Museum.

Williams (1945:421–422) recorded this species as a parasite (predator?) in the cells of *Eumenes germaini* Lucas in New Caledonia; "On one occasion, the hairy and spiny pupal shell of the bombyliid was observed partially extruded from the mud nest of the wasp, on another occasion the pupa had produced its fly within the closed mud cell." This species probably preys upon *Eumenes* in Hawaii but no observations have been made here to date.

A. distigma is apparently distinguished from other related *Anthrax* by having isolated spots of brown in the hyaline apical portion of the wing and the brown markings extending obliquely across the wing from end of subcostal cell over r–m and cu crossveins, not extending continuously over bases of veins R_4 and M_3

(fig. 113a); also the male genital characters are distinctive, as shown in figure 113c. This species has been adequately described by Engel (1938a:428) and by Brunetti (1920:218, under *Argyramoeba*). It is an entirely black species except for the yellow apices of the halteres. The pile of the head is predominantly black, with white pile interspersed over the face, front, and occiput; pile of postocciput brown; that of pleura white, with some black pile on upper portion; that of mesonotum and scutellum largely black interspersed with white, with dense long white pile along anterior margin of mesonotum; also with a dense patch of white and black hairs intermixed on the scutellar bridge above each squama. First tergum of abdomen with a dense clump of white hairs on sides, pile on lateral margins of terga 2 to 4 largely black; terga 3 and 4 with a small patch of silvery white scales near sides; terga 5 and 6 with a dense clump of silvery white scales on sides and tergum 7 almost entirely silvery white. Genital portion of female densely yellow pilose. Antenna, wings, and male genitalia as in figures 113a, b, and c.

Length: body, 8.0–10.0 mm.; wings, 8.8–12.0 mm.

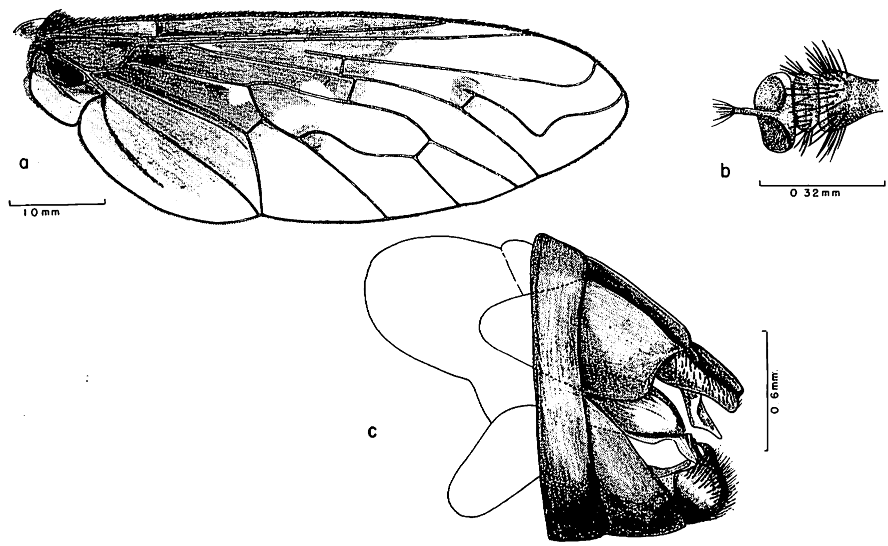

Figure 113—*Anthrax distigma* Wiedemann: **a,** wing; **b,** antenna; **c,** male genitalia, lateral view.

Family SCENOPINIDAE Fallén

Window Flies

Scenopinos Fallén, 1815, Dipt. Sveciae: Platypezinae et Bombylarii Sveciae, p. 4.
Scenopinii Fallén, 1817, Dipt. Sveciae: Dispositio Dipterorum Synoptica, p. 11.
Scenopinidae Westwood, 1840, Int. Mod. Class. Ins., 2:553.
Omphralidae Kertesz, 1909, Cat. Dipt., 5:171.
For other synonyms see Handlirsch, in Schröder (1925:986).

The name comes from the Greek skene, house or dwelling, and pinos, dirt or filth.

Moderately small, chiefly black flies, characterized by the comparatively elongate body (fig. 114), by the wing venation and by the form of the antenna. The third antennal segment is two or more times longer than wide and possesses no style or arista (fig. 115c). Vein R_4 is present and the apical cell is open in the Hawaiian species (fig. 115b).

Very little is known of the biology of these flies except that the larvae are predaceous, preying, perhaps, on a variety of different insects. *Scenopinus fenestralis* (Linnaeus) has been recorded in association with carpet beetles, *Anthrenas* sp.; clothes moths; *Lucilia dispar* Dufour = *Protocalliphora azurea* (Fallen) in swallow nests; *Ptinus germanicus* Olivier; *Hylotrupes bajulus* (Linnaeus); and fleas. *Belosta albipilosa* Hardy (Hardy, 1944:39–40) apparently preys upon wood-boring beetles, *Dendroctonus brevicornis* Lec. or *Monochamus* sp.? The larvae of *S.* (*Paromphrale*). *glabrifrons* Meigen has been reported in the nests of *Sturnus vulgaris* Linnaeus. *Archiscenopinus niger* (DeGeer) has been found living in cocoons of *Saturnia pyri* Schiffermüller (see Kröber, 1938:2) and also in animal food infested with clothes moths. Females of the three Hawaiian species are commonly found on windows. Females of *S. adventicia* n. sp. have been observed hovering near the ground beneath a house where larvae of the casemaking clothes moth were present. Male specimens are rarely found on windows; we take an occasional male of *Lucidomphrale lucida* (Becker), but have never observed male specimens of the other two species on windows. The only practical way to collect males has been to rear them from cultures of cigarette beetles (*Lasioderma serricorne* (Fabricius)), flower beetles (*Tribolium castaneum* (Hbst.)), carpet beetles (*Anthrenus* spp.), clothes moths (*Tinea* spp.), and probably cultures of other insects. The males of *Lucidomphrale lucida* are frequently encountered hovering in small swarms in the sunlight in certain areas. At one spot at Hanauma Bay which I have visited many times, males are always found hovering beneath a small *Prosopis* ("kiawe") tree; I suspect that the larvae probably feed upon Bruchidae or Anthribidae in the seed pods of this tree.

Some biological notes have been made on *S. adventicia* n. sp. The eggs are oblong in shape and brownish-yellow in color. They are expelled forcibly from the abdomen; the female seems to flip the eggs from the tip of the abdomen with considerable force. When observing them under a microscope, the egg can be seen as it emerges from the ovipositor and it is held momentarily, about half extruded, and then is suddenly propelled. Females have been observed to "throw" eggs the entire length of a 60-mm. vial. The eggs are obviously widely scattered and stick to whatever surface they contact. They require 7 to 9 days to hatch under laboratory conditions, and the larval and pupal stages last 3 to 5 weeks. The first instar larvae are but 1.7 mm. long. The larvae are white, elongated and cylindrical, and have 20 visible segments. The head is small and heavily sclerotized.

The male genitalia are of considerable importance in the taxonomy of these flies, although these structures have seldom been used in the literature. In the

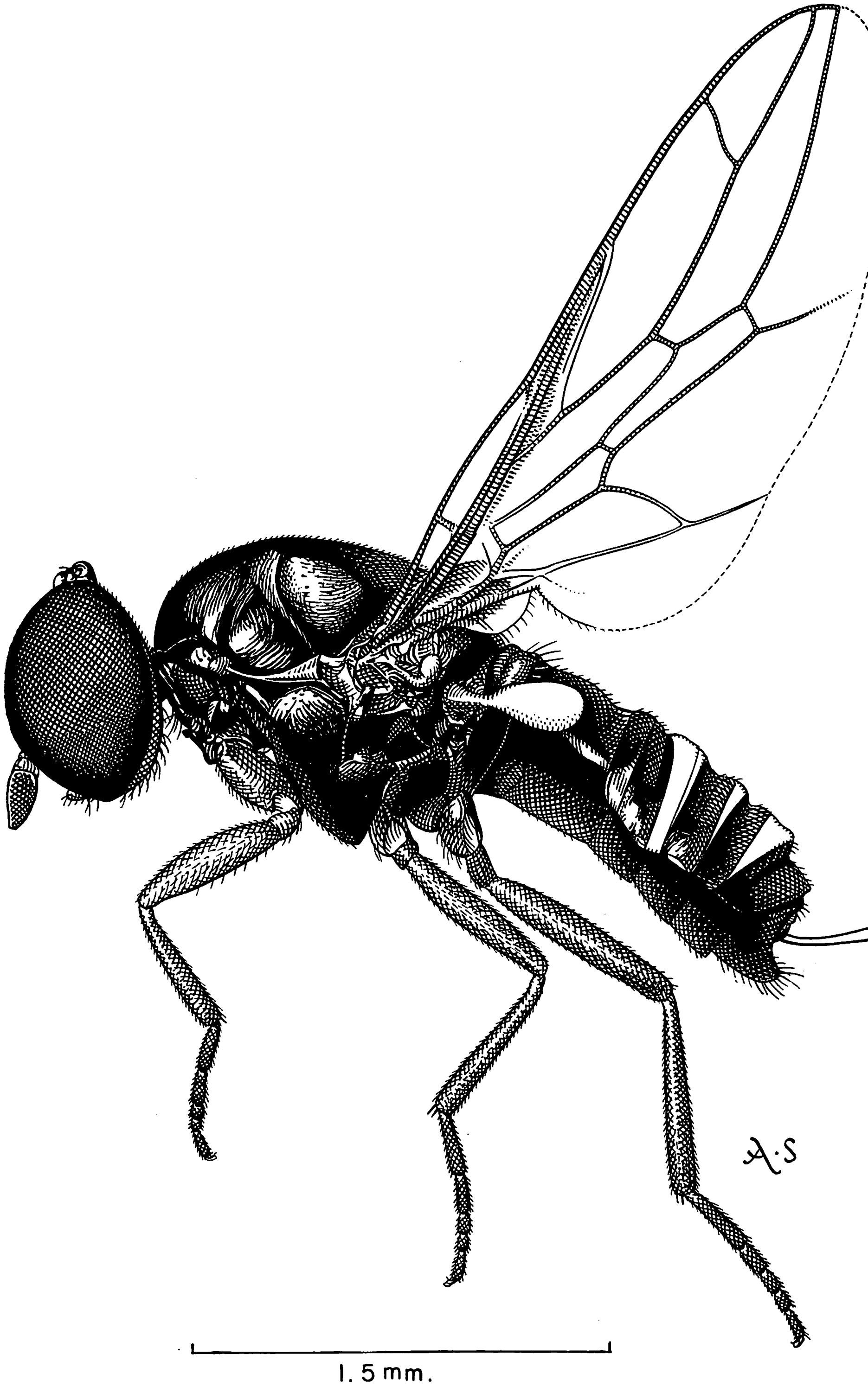

Figure 114—*Lucidomphrale lucida* (Becker). Adult male.

two genera represented in our fauna, the genitalia are completely turned over so that tergum 9, cerci, and anal region are situated on the venter and the sternum, claspers, aedeagus, and accessory structures are dorsal in position. In the majority of the species which I have studied, tergum 9 is divided into two lateral plates which fold around on to the dorsum of the genitalia and enclose the internal structures in a protective covering. Sternum 9 is developed in the median portion of the dorsum; often its posterior median margin extends over the top of the aedeagus. The coxites of segment 9 (claspers) are small, rather poorly developed, and usually hidden by the edges of the tergum (fig. 115d). Segment 8 is ring-like (a narrow ring-like band), usually hidden. The female genitalia have not previously been used taxonomically. The shape of the gonapophyses of segment 8 (note: the gonopore is always on segment 8) the vestiture of sternum 9 (the dorsal plate of the egg channel, bearing pegs or setae), and also the cerci-like structures at the tip of the abdomen seem to be of taxonomic importance (figs. 115e, 116f, and 117c). The apical lobes, which would appear to be cerci, are probably equal to terga 9 and 10 (enough segments cannot be accounted for for these to be cerci). True cerci are probably not developed in these flies.

Key to the Known Hawaiian Species of Scenopinidae

1. Coxae and femora black, tarsi yellow to rufous. Front of female and thorax of both sexes shagreened, subshining to opaque, with pubescence on the humeri and sides of mesonotum. Male genitalia without elongate processes (fig. 116e) 2

   Coxae and femora yellow to rufous, tarsi brown to black. Front of female and thorax of both sexes smooth, with no pubescence, and polished black. Male with a pair of long bristle-like processes extending from the inner portion of the genitalia (fig. 115d). (Known from north and central Africa and Oahu) .... **Lucidomphrale lucida** (Becker).

2. Wings dusky, distinctly brownish fumose. Vein R_4 branches off before the half-way point between the r–m crossvein and the wing margin (i.e., vein R_5 is longer than that portion of R_{4+5} between the fork and r–m) (fig. 117b). Abdomen short and broad, usually about equal in length to the thorax. All tibiae dark brown to black. Abdomen of male without white bands. Halteres brown to black and the front of the female nearly four times longer than wide. (Formosa, New Guinea, Mariana Islands, and Oahu) .... **Scenopinus papuana** (Kröber).

   Wings hyaline. Vein R_5 about half as long as that portion of R_{4+5} between the fork and r–m crossvein (fig. 116b). Abdomen slender, usually one-half longer than the com-

bined lengths of the head and the thorax. The front two pairs of tibiae yellowish. Male abdomen with two white crossveins. Halteres of males with white knobs and front of female about two times longer than wide. (Oahu). .... **Scenopinus adventicia** n. sp.

Genus **LUCIDOMPHRALE** Kröber

Lucidomphrale Kröber, 1937, Stett. Ent. Zeitsch. 98:219.

This genus is characterized largely by the presence of the pair of long bristle-like processes extending from the inner portion of the male genitalia (fig. 115d). I suspect that this may be a specific character. The group is monotypic.

Genotype *Lucidomphrale lucida* (Becker).

Lucidomphrale lucida (Becker) (figs. 114, 115a–e).
Scenopinus lucida Becker, 1902, Mitt. Zool. Mus. Berl. 2:39.
Lucidomphrale lucida (Becker), Kröber, 1937, Stett. Ent. Zeitsch. 98:222.

Oahu, Molokai, Lanai, Kaula Island, and probably general throughout the Hawaiian Islands.

Immigrant. Outside of Hawaii it is known from Egypt, Eritrea, and the Belgian Congo.

The type was in the Zoological Museum, University of Berlin. Dr. W. Hennig (Deutsches Entomologisches Institut) has informed me that Becker's type has been completely destroyed by *Anthrenus* and only the minuten nadeln and the labels remain.

Kröber's definition of this genus and species is somewhat misleading. He indicates that the first two antennal segments of the female are somewhat club-shaped and are about two times longer than wide; in his key (1937:219), however. he says, "Etwas länger als breit." In all of the specimens which I have studied, the first two segments are approximately as long as wide as seen from a top view, and are very slightly more slender than those segments on the other Hawaiian species. I can see no evidence of the segments being club-shaped and have not been able to confirm Kröber's statement. From a lateral view the first two segments are distinctly broader than long. I have compared with specimens from Elizabethville, Belgian Congo, and our material agrees in all details with that from Africa. Kröber's figure 13 (1925, Taf. B) shows the eyes of the male approximating one another for a very short distance on the front; the specimens which I have studied have the inner margins of the eyes parallel on the upper third of the front (fig. 115a). The only character which I have observed which appears of any generic importance is the development of bristle-like processes on the male genitalia. *L. lucida* is the only known species which possesses this characteristic and it may possibly be just a specific character. I have seen slight developments of the parameres of other Scenopinidae. The smooth, polished integument of the

female front and the anterior and lateral areas of the thorax of both sexes might possibly be of some generic significance. It would perhaps be best, however, to consider *Lucidomphrale* as a subgenus of *Scenopinus*.

L. lucida (fig. 114) can be differentiated from all known species of this family by the characters given in the above key. In addition to these details, the first two antennal segments are brownish-yellow, are about as long as wide from a dorsal view, and are distinctly wider than long from a lateral view. The eyes of the male are separated on the front by a distance equal to about half the width of one ocellus (fig. 115a). The front of the female is highly polished and is two times longer than wide (measured from the antenna to the median ocellus). The mesonotum is more highly polished on the anterior and lateral margins. The knobs of the halteres are white in both sexes. The tibiae are brown to black, tinged with rufous, especially on the front pair. The wings are hyaline, the veins are brownish yellow. The venation is as in figure 115b. The male has a broad white band across the apex of segment 3 and has narrow white bands across apices of segments 4 and 5. *Genitalia:* The lateral plates of tergum 9 are very slightly joined by a narrow semi-membranous portion in the middle of the hind margin (ventral aspect of the genitalia); a narrow V-shaped concavity separates the two lateral lobes. Each sidepiece is rather strongly developed on the venter (fig. 115d) and comparatively poorly developed on the dorsolateral aspects; they do not extend onto the dorsum and do not surround the inner portions of the genitalia. The posteromedian portion of sternum 9 is developed into a slender lobe which extends three-fourths the length of the claspers. The claspers are well developed and are

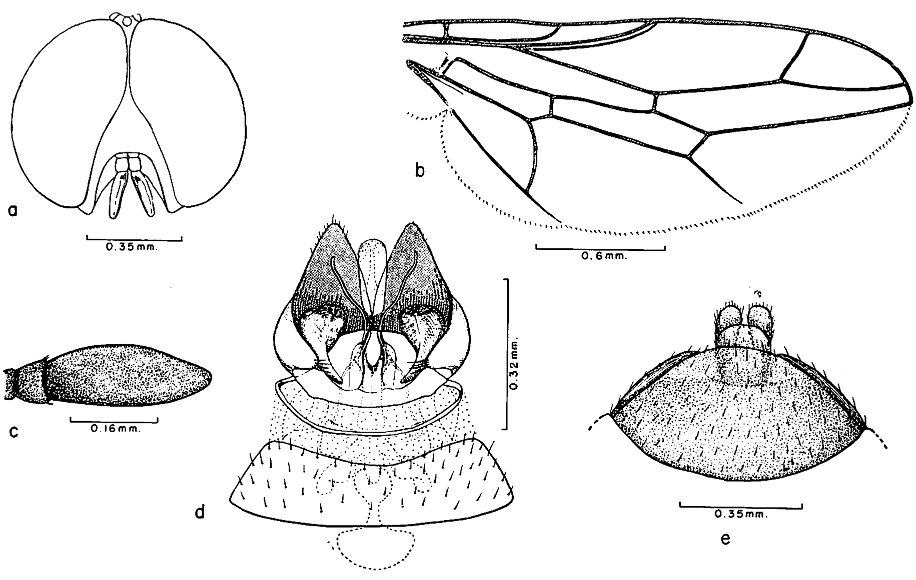

Figure 115—*Lucidomphrale lucida* (Becker): **a,** male head, front view; **b,** wing; **c,** antenna; **d,** male genitalia, dorsal view; **e,** female genitalia, dorsal view.

boomerang-shaped as seen in dorsal view. The elongate processes which protrude beyond the genitalia arise at the base of the aedeagus and appear to be developments of the parameres. The females have the margins of tergum 9 straight. The dorsal surface of the egg channel is sparsely covered with setae (fig. 115e).

Length: body, 2.8–4.0 mm. (averaging about 3.0 mm. in the males and 4.0 mm. in the females); wings, 2.5–3.3 mm.

This species is common on Oahu and possibly on all of the other islands. I have seen specimens from numerous localities collected during most months of the year. The females are found on windows, and the males are usually found hovering in the sunlight, often along the beaches.

Brunetti's record of *Scenopinus fenestralis* (Linnaeus) from Hawaii (1920:312) was evidently an error and should refer to *L. lucida*. Bryan's records of *S. fenestralis* (1924:365, 368, and 1933:245) and also Fullaway's "new fly . . . [with] a pair of caudal hooks . . ." (1923:204) obviously were this species.

I have reared this species in cultures of *Tribolium castaneum* (Hbst.) and *Anthrenus* spp.

Genus **SCENOPINUS** Latreille

Omphrale Meigen, 1800, Nouv. Class., 29. Rejected name.
Scenopinus Latreille, 1802, Hist. Nat. Crust. et Ins. 3:463.
Atrichia Schrank, 1803, Fauna Boica 3:54.
Hypselura Meigen, 1803, in: Illig. Mag. f. Ins. 2:273.
Cona Schellenberg, 1803, Genres de Mouches, p. 66.
Scenopoeus Agassis, 1846, Nomenclat. Zool. Univ. Ind., 333.
Astoma Lioy, 1864, Atti Apeneo Veneto, Ser. 3, 9:762.
Scaenopius Dalla Torre, 1878, Jahr. Natur. Ver. Lotos 27 (1877):161.

The members of this genus are moderately robust in build, chiefly black in color, usually with white crossbands on the abdomen of the males. Cell R_5 (apical) is open; vein R_5 is not united with M_{1+2}. The mouthparts are well developed and occupy most of the facial depression. The third antennal segment is moderately elongate and almost parallel sided. The genus contains about 50 known species for the world. Two occur in Hawaii.

Type of genus: *Musca fenestralis* Linnaeus.

In Kröber's key to the genera of Scenopinidae (1937:218–219), our two species of *Scenopinus* would run to his genus *Paromphrale* because of the narrowly separated eyes of the male ("Augen des♂ schmal getrennt, . . ."). They differ from his description of *Paromphrale* by having the front of the female finely shargeened and subshining, not smooth and polished. In my revision of the North American species (Hardy 1944:42) I have treated *Paromphrale* as a subgenus of *Scenopinus* [*Omphrale*]. I now question whether it would be preferable to treat this as a direct synonym since the differentiating characters which I have observed do not appear to be even of subgeneric value. From Kröber's figure of the head of the genotype (1938, pl. B, fig. 3), the eyes appear to be separated about the width of the median

ocellus. The species in this genus vary considerably in respect to the approximation of the eyes on the front from those with distinctly separated eyes to those which have the eyes joined for nearly half the length of the front. I cannot see, at the present time, how the species can be satisfactorily grouped on the basis of this character.

Scenopinus adventicia, new species (figs. 116a–f).

Oahu; probably widespread over the other major islands.

Immigrant. Source unknown.

This species has obviously been introduced into Hawaii although I am unable to find any description in the literature which fits it. It has been referred to a number of times in our literature as a member of the complex which has been treated under the name "*Scenopinus niger* Meigen" (error in authority for De-Geer). This is probably the species which Grimshaw recorded as *S. niger* (1901:11). This species seems to fit nearest *Scenopinus longiventris* (Kröber) from India and Ceylon, but the wings are not milky white, cell 1st M_2 is not unusually short, and the body is not unusually slender; the abdomen is slightly more than 1.0 mm. wide, not "hochstens ⅔ mm. breit." *S. longiventris* is known only from the females, so the characteristics of the males cannot be compared. It also fits fairly close to *Scenopinus beameri* (Hardy), but differs in a number of ways. *S. adventicia* is larger (3.0–4.5 mm. body length, compared to 2.3–2.5 mm. in *beameri*). The occiput of the female is narrow, the upper portion not wider than one ocellus; in *beameri* the occiput is expanded, the width of the upper portion about equal to the length of the ocellar triangle. The halteres are chiefly blackish in the females of *adventicia*; in *beameri* they are white in both sexes. In *adventicia* the head of the male is one-third wider than long, as seen from front view; the abdomen possesses just two transverse white bands; and the genitalia are distinctive (fig. 116e). In *beameri* the male head is one-fifth wider than long and the abdomen has three transverse bands. For the details of the genitalia see Hardy (1944:43 and 49, fig. 6a).

MALE. *Head:* The eyes are separated on the front by a narrow black line about one-fourth as wide as the median ocellus. The narrowed portion of the front (where the eyes are approximated) is one-third longer than the lower portion of the front. The lower portion of the front is subshining black, finely rugose, except for a densely gray pubescent area on each lower corner. This pubescence continues as a broad line down each side of the face. Each compound eye is divided into two parts by an area of smaller facets on the lower two-fifths. The antennae are dark brown to black; the third segment is less than three times longer than wide and is thickest on the basal third (fig. 116a). *Thorax:* Subshining black, finely rugose, with a faint bronze sheen on the dorsum, and more polished on the pleura. Mesonotum rather thickly covered with short, gray (inconspicuous) pile and with a patch of gray pubescence on the front margin, just inside each humerus. The stems of the halteres are brown to black, the knobs are white. *Legs:* The coxae, trochanters, and femora are black; the latter have a row of moderately long, fine gray hairs extending the full length on each extensor surface. The first

two pairs of tibiae are yellowish to rufous, tinged with brown to black. The hind tibiae are blackish on the basal halves and rufous, tinged with brown, on the apices. The tarsi are chiefly rufous, the apical segments brownish. *Wings:* Hyaline, faintly grayish, the stigma very pale yellow and the veins brownish. The r–m crossvein is situated just beyond the middle of cell 1st M_2 and the furcation of vein R_4 and R_5 is situated near the apical third of cell R_5 (fig. 116b). *Abdomen:* One-fourth to one-fifth longer than the thorax and almost two times longer than wide. The terga are chiefly opaque brown on the dorsal portions and are polished black on the sides. Terga 3 and 4 are narrow, and a broad section (about equal to median length of tergum) of white conjunctiva is exposed along the hind margins of the segments (fig. 116c). *Genitalia:* Moderately well developed, *in situ* the visible portion equal in length to the last two (visible) abdominal segments. Two sclerotized plates (tergum 9) (fig. 116e) are developed on each side, curving around and forming a protective chamber for the aedeagus and other portions of the genitalia. These plates are lobate on the ventral portions so that the posterior dorsal surfaces are shorter than are the ventral. The claspers are small and are hidden inside of the genital chamber; they are thickened at bases and tapered to apices. From a ventral view the plates of the tergum (the genitalia are turned completely over in this genus) are united briefly on the posterior median margin (fig. 116d). The cerci are about two times longer than wide.

Length: body, 3.0–3.7 mm.; wings, 2.3–2.6 mm.

FEMALE. Slightly larger than the male. The front is nearly parallel sided, just slightly expanded on the upper portion. The front is subshining black, rather coarsely rugose, and with a shallow groove extending the full length down the middle. The front, measured from the median ocellus to the antennae, is slightly less than two times longer than wide. The halteres are whitish on the ventro-apical portion of the knobs, they are otherwise brown to black. The abdomen is about two and one-half times longer than wide and over twice as long at the thorax. The abdomen is entirely subshining black, with no white bands. The female genitalia are as in figure 116f; the apical margin of sternum 9 has a small V-shaped concavity in the middle and the dorsal surface of the egg channel bears scattered setae.

Length: body, 4.0–4.5 mm.; wings, 3.5 mm.

Holotype male and allotype female: reared from *Tribolium castanium* (Hbst.) culture, Honolulu, Oahu, January, 1953 (D. E. Hardy). Paratypes (about 50 females and 10 males): most from Honolulu, 1953–1956, taken predominantly on windows at the University of Hawaii; most all months of the year are represented (D. E. Hardy, M. S. Adachi, C. Hoyt). All of the males except three were reared from a culture of *Tribolium*. Some of the female specimens have been reared from casemaking clothes moths (*Tinea pellionella* (Linnaeus)) and from carpet beetles (*Anthrenus* sp.?). Also 1 female Manoa Valley, Oahu, on window, December 26, 1951 (O. H. Swezey); 1 female Waipio, Oahu, September, 1955 (D. E. Hardy); and 1 male Ewa, Oahu, light trap, January 21, 1952 (Pemberton).

The type, allotype, and a series of paratypes are in the B. P. Bishop Museum.

Paratypes are being deposited in the following collections: U.S. National Museum; Hawaiian Sugar Planters' Association; British Museum (Natural History); Deutsches Entomologisches Institut; and the University of Hawaii.

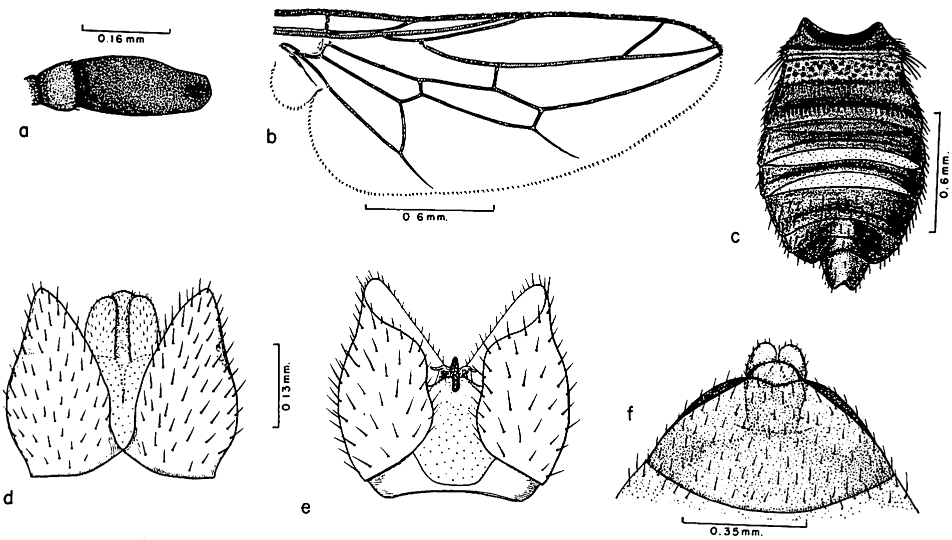

Figure 116—*Scenopinus adventicia* n.sp.: **a,** antenna; **b,** wing; **c,** male abdomen, dorsal view; **d,** male genitalia, ventral view; **e,** male genitalia, dorsal view; **f,** female genitalia, dorsal view.

Scenopinus papuana (Kröber) (figs. 117a–e).

Scenopinus niger Grimshaw, 1901, Fauna Haw. 3:11. *Nec* DeGeer, 1776, Ins. ed. Götze 6:76.

Omphrale papuana Kröber, 1912, Suppl. Ent. 1:25.

Omphrale? sp. #1 Hardy, 1952, Proc. Haw. Ent. Soc. 14:451.

Oahu, Maui, Hawaii; probably on all the main islands.

Immigrant: Formosa, New Guinea, and Mariana Islands. (Type from Kanshirei, Formosa.)

Type in the Deutsches Entomologisches Institut.

This species is readily distinguished from other *Scenopinus* by the dusky fumose wings; by the wing venation as shown in figure 117b; and by the characteristics of the male genitalia (figs. 117d and e). The species has been recorded in the Hawaiian literature a number of times under the name "*Scenopinus niger* Meigen;" this is an error for *S. niger* (DeGeer). Grimshaw (1901:11) made the original error when he said two female specimens from Hawaii "agree tolerably well with European specimens of this species." The error has been carried on in our literature until I pointed out (Hardy, 1952:451) that our species is quite different from *Archiscenopinus niger* (DeGeer). At that time I stated that our

species probably belongs in the genus *Scenopinus* [*Omphrale*] but since only females had been seen it could not definitely be placed (using Kröber's classification).

Specimens have been sent to Dr. W. Hennig, Deutsches Entomologisches Institut, Berlin, for comparison with the type female from Kanshirei, Formosa. After making the comparison he reported that he was convinced that our material is identical with *Omphrale papuana* Kröber. He said that the specimens from Hawaii were very slightly smaller than the type but that in other details they seemed to agree perfectly. Dr. Hennig pointed out a number of discrepancies in Kröber's original description. Kröber indicated that the front is moderately broad in *papuana* and that the abdomen is 2.0 mm. wide. Hennig found that the widths of the front and the abdomen are the same in the material from Hawaii and the type. In our material the front is comparatively narrow, being almost four times longer than wide, and the abdomen is approximately 1.0 mm. wide.

Moderate sized, predominantly black species. The antennae are black, tinged with brown or reddish brown; the third segment is approximately three and one-half times longer than wide (fig. 117a). In the female the front is about four times longer than wide; is chiefly subshining black with a shining black furrow running the entire length down the middle and a shining black line extending the full length down each eye margin. In the male the upper half of the front is narrowed to a thin shining black line. Thorax subshining black, finely shagreened; the anterior portion is gray pollinose on each side just inside the humeri. The posterior lateral margins of mesonotum (postalar area) are yellow to rufous. The halteres are brown to black. Legs predominantly dark brown to black, the tarsi yellow. Wings rather densely fumose; the stigma is scarcely darker than the wing membrane. Vein R_4 forks at a position before the middle of that section from the r–m crossvein to the wing apex. In other species of *Scenopinus* which I have studied, this forking occurs beyond the middle of this section so that the free portion of vein R_5 is considerably shorter than that portion of R_{4+5} from the r–m crossvein to the furcation. The other details of the wing venation are as in figure 117b. Abdomen entirely subshining brown to black with no white transverse markings in either sex. The abdomen is comparatively short and thick. In the male at hand it is nearly as wide as long. In the female specimens it is at least two-thirds as wide as long. *Genitalia:* Tergum 9 of the male is completely divided into two plates which approximate each other on the lower median margin of the ventral aspect of the genitalia (fig. 117d). The lateral plates of the tergum do not extend as far around the dorsal portion as in most species of this genus and do not obscure the inner portions of the genitalia. Each plate of the tergum is developed on the dorsolateral portion into a pair of strong lobes (fig. 117e). The claspers are moderately well developed, are thickened at bases, curved slightly inward, and truncate at apices (fig. 117e). The median portion of the genitalia (median portion of 9th sternum?) as seen from a dorsal view, is rather slender, extending about half the length of the claspers, and has a V-shaped concavity in the middle of the hind margin (fig. 117e). Directly below this sclerotized portion is a pair of short, curved, hook-like parameres, beside the aedeagus. The 9th sternum of the female has a small pointed convexity in the middle of the hind

margin (fig. 117c). The inner surface (ventral) of the sclerite lying directly below the anal region (dorsal surface of the egg channel) is rather densely covered with short peg-like setae (fig. 117c).

Length: body, 3.2–4.0 mm. (Kröber recorded the body length as 4.0–4.5 mm.); wing, 2.7–3.5 mm.

This species apparently is not as abundant as are the other two Scenopinidae although it appears to be much more common in some areas than in others. I find it but very rarely on the windows at the University, while it has been taken rather commonly on the windows at the Bishop Museum. Numerous specimens are at hand mostly from Honolulu and Manoa Valley. They have been taken practically all months of the year and date from 1905 to 1951. Some of the specimens have been reared from yeast cakes infested with cigarette beetles (*Lasioderma serricorne* (Fab.)). The male specimen was obtained in this manner. One specimen is also at hand from the Ewa Coral Plain, 11–29–16, Oahu, (J. C. Bridwell).

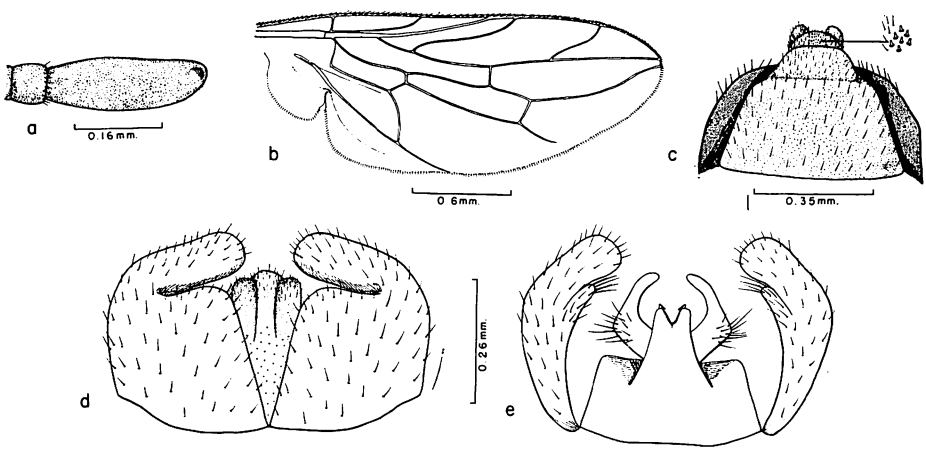

Figure 117—*Scenopinus papuana* (Kröber): **a,** antenna; **b,** wing; **c,** female genitalia, dorsal view; **d,** male genitalia, ventral view; **e,** male genitalia, dorsal view.

Family EMPIDIDAE Latreille

Dance Flies, Empid Flies

Empides Latreille, 1805, Hist. Nat. Gen. des Crust. et des Ins. 14:310.
Empidides Billberg, 1812, Enum. Ins. Mus. Billberg, Stockholm 4:120.
Empidos Fallen, 1814, Dipt. Sveciae: Asilici Sveciae, p. 2.
Empidiae Fallen, 1815, Dipt. Sveciae: Empidiae Sveciae, p. 3.
Empidae Samouelle, 1819, Entomologists Useful Compendium, p. 295.
Empites Newman, 1834, Ent. Mag. 2:392.

Empididae Lameer, 1906, Mem. Soc. Ent. Belgique 12:127.
For other synonymy see Handlirsch, in Schröder (1925:994).

The name of the type genus, *Empis*, comes from the Greek empis, a mosquito, gnat.

Moderately small, dark-colored, predaceous flies; the Hawaiian species range in size from 1.5 to 2.5 mm. The species in our fauna are easily recognized by the shape of the body, head and appendages (fig. 119d), and by the wing venation (fig. 118b). The most distinctive characters are: the porrect antennae, with an apical style; the rigid, moderately developed proboscis; the emarginate eyes; the rather short, thick body; and the complete lack of an anal vein, cubital cell, or cell 1st M_2.

This is a large family, generally distributed throughout the world; the species usually occur in moist situations. The common name, dance fly, comes from the mating reactions of many of the species. The individuals congregate and dance up and down in large swarms. Usually the swarm consists only of males, and the females enter it only to select a mate, sometimes continuing to fly with the swarm and in other cases leaving the swarm to settle on nearby vegetation. The males of some species capture insects and present them to the females as a "wedding present" (stimulus for mating). Other species of the genera *Hilara* Meigen, *Empis* Linnaeus, and *Empimorpha* Coquillett are commonly called balloon flies because of the balloons which the males construct from silk globules or silk-like threads, probably produced from secretions of anal glands (see Kessel, 1955:103), and used as an attractant for the female. The balloon usually contains a small insect, which is fed upon by the female during copulation. Kessel has studied the mating activities of these flies for many years and has published excellent reports of his observations (1947 and 1955). Based upon mating activities, he has found that members of the family fall into eight stages, which fit into an evolutionary sequence. The first is a generalized predaceous stage in which the male does not bear a wedding gift; the prey is captured and devoured by both sexes independently. In the second stage the male captures the prey and searches out the female and presents it to her as a mating stimulus. In the third stage the male captures the prey but does not search out the female; instead he joins other males bearing gifts in an aerial dance of eligible bachelors and the female takes the initiative, flying into the swarm to take out a mate. The prey evidently is the stimulus for copulation. In the fourth stage the prey, presented by the male to the female, is entangled in silken threads (a gift package). In the fifth stage the prey is enclosed within a complex balloon. In the sixth the balloon contains an insect or spider, but the prey no longer serves as food for the female but probably does serve, along with the balloon, as a mating stimulation. In stage seven the prey is minute, often consisting of just fragments plastered onto the balloon, and is of no use as food and probably has no use as a mating stimulus for the female. It still serves, however, as a stimulus for the male to construct the balloon, insomuch as he always begins by capturing the prey. In the last stage of the evolutionary sequence, the male no longer captures a prey for use in attracting the female and presents only the empty balloon.

Little is known of the habits of the Hawaiian species; none have been observed dancing in mating swarms, although *Crossopalpus insularis* (Melander) has been observed flying in swarms of *Milichiella lacteipennis* (Loew) (feeding). This species is associated with dairy farms, preying on insects breeding in manure. One species (*Chersodromia hawaiiensis* Melander) lives on the beaches and has been associated with crab holes. The third known Hawaiian species (*Chersodromia dissita* Collin, n. sp.) has been taken sweeping vegetation in the wet rain forest regions on several of the Islands at elevations of 4,000–5,000 feet.

For monographic studies of this family refer to Melander (1918 and 1927), Engel (1938b and 1939), Lundbeck (1910), and Frey (1952, 1953, and 1955).

Subfamily TACHYDROMIINAE Meigen

Tachydromiae Meigen, 1822, Syst. Beschr. Zweifl. Ins. 3:61.
Tachydromides Wiedemann, 1830, Auss. Zweifl. Ins. 2:11.
Tachydrominae Schiner, 1862, Fauna Austr. Dipt. I:LI.

The members of this subfamily are characterized by lacking cell 1st M_2 (1st M_2 is combined with cell M); by the cubital cell and anal vein lacking or incomplete; and by the subcosta being vestigual and vein R_{4+5} simple.

KEY TO GENERA AND SPECIES KNOWN FROM HAWAII

1. Radial cell as long as medial cell (1st basal as long as second basal) (fig. 118b). Two pairs of ocellar bristles. Opaque gray pollinose species. Hind tibia very slightly produced at inner apex and bristles at apex of middle tibia rather weak, not over two times the width of the segment. **Chersodromia** Walker 2

   Radial cell much shorter than cell M (fig. 119d). One pair of ocellar bristles. Metallic, black species. Hind tibia strongly produced into a densely yellow pubescent, flat process on inner apex (fig. 119b). Bristles at apex of middle tibia strong, at least three times the width of the segment. . . . . **Crossopalpus insularis** (Melander).

2. One pair of vertical bristles. Thorax predominantly yellow, with a brown to black vitta down middle of mesonotum. Male genitalia very large, equal or slightly longer than remainder of abdomen, the ventral plate yellow . . . . **Chersodromia dissita** Collin n. sp.

   Two pairs of vertical bristles present. Thorax black in ground color. Male genitalia comparatively small and entirely brown to black . . . . **Chersodromia hawaiiensis** Melander.

Genus **CHERSODROMIA** Walker

Chersodromia Walker, 1851, Insecta Britannica, Dipt. I:137.
Halsanalotes Becker, 1902, Mitt. Mus. Berlin 2(2):41.

Engel (1938b:7) differentiates this genus from *Coloboneura* Melander by its having very narrow genae, at most one-sixth the eye height, rather than having the genae one-third as broad as the eye height; by vein R_1 ending near middle of wing, rather than near apical two-thirds; by the first section of costa long-haired, rather than not haired; by the femora not strongly bristled; by having only one presutural dorsocentral bristle, rather than two; by the antennae appearing to be 2-segmented, rather than with three distinct segments; and by the pulvilli being small, rather than large. The Hawaiian species have moderately developed pulvilli, nearly as long as the claws (I am not sure what Engel means by large and small); also, the antennae are rather distinctly 3-segmented, the basal segment is small but a definite articulation with the second is visible. From Engel's figure of the wings of *Coloboneura* (1938b:36, fig. 29) and *Chersodromia* (page 41, fig. 31) I see no particular value to the wing characters which he uses; in his figure of *Coloboneura* R_1 ends just slightly beyond middle of wing (nearly three-fourths the distance from base to apex), not at the apical two-thirds.

Two species occur in Hawaii. Both are known only from these Islands; one is probably introduced, the other probably endemic.

According to Engel (1938b:37), nothing is known of the biologies of species of *Chersodromia*.

Type of genus: *Tachypeza arenaria* Haliday (*brevipennis* Zetterstedt is a synonym).

The description of the new species which follows was prepared by J. E. Collin, Newmarket, England.

Chersodromia dissita Collin, **new species** (figs. 118a–c).

A greyish species with yellow pleura and legs. Front with only one pair of vertical bristles, and male hypopygium mainly yellowish and very large.

MALE. *Head:* Frons and face dull greyish, former narrow in front, latter narrow above (width of first antennal joint) widening out to vertex and mouthedge. Proboscis and palpi yellow, latter elongate-ovate, comparatively small. Jowls [genae] below eyes yellowish and about width of second antennal joint. Occiput prominent, dark and dusted greyish above, becoming yellowish below where it is devoid of pubescence, otherwise pubescence dark and very short except towards vertex. Ocellar triangle with the usual two pairs of black bristles, but only a single pair of vertical bristles wide apart near eye-margin; all these bristles equally well developed. Antennae yellow, third joint short ovate, not longer than two basal joints combined, arista brownish, slightly supraterminal, somewhat thickened by microscopic pubescence, and nearly twice length of antenna (fig. 118a). *Thorax:* Mainly yellowish, but disc and scutellum darkened, usually leaving a

large humeral area, and postalar calli yellow. A coating of greyish dust scarcely hides the ground colour. Pleura yellow, dusted greyish except on sternopleura, and to a less extent on pteropleura, which consequently are more shining. Chaetotaxy well developed, with the stronger dark bristles consisting of four pairs of dorsocentrals (becoming shorter towards front) a very long upcurved humeral, a distinct post-humeral (quite twice as long as front dorsocentral), two notopleurals, a supraalar, a postalar, and four scutellars (basal pair small). The much smaller acrostichal setulae mainly biserial, quite short in front, rather longer behind, and not extending to scutellum.

Legs: Pale yellow. All femora rather stout and front tibiae somewhat spindle-shaped. The usual apical bristles of femora and tibiae fairly well developed. Front and middle tibiae with two small anterodorsal bristles, hind tibiae with two pairs of dorsal and two anteroventral bristles. Middle tibiae also with the usual anteroventral serration of small dark spines on apical half.

Wings rather long and narrow with yellowish veins, basal costal bristle strongly developed, costal section between first two veins scarcely thickened, crossvein closing second basal cell slightly before end of first basal cell (fig. 118b). Halteres large, pale yellow. *Abdomen:* Composed of seven visible segments, with seventh longest and yellowish, others subequal and dull brownish, eighth hidden beneath seventh except at middle. Venter yellowish. Pubescence very short and inconspicuous except on hind margin of seventh tergite especially at sides. Hypopygium (fig. 118c) very large and yellowish (paler below), practically as long and as wide as rest of abdomen. It is mainly composed of the large pale yellow, tumid, right lobe (ventral in position owing to twist in hypopygium), articulated to end of this lobe is a spoon-shaped lamella which curves around towards and over the anal papillae which lie between this right lobe and the much smaller, dorsal, left lobe; this latter also spoon-shaped but not much curved. Some scattered setae present on the tumid right lobe becoming much more numerous and longer on its hind margin.

FEMALE. Apparently often darker than male without yellowish color on humeral region and pleura, but variable, perhaps according to maturity. Abdomen with eight segments, the apparent eighth narrower and more pubescent, as are also the rather stout, almost equally long, terminal papillae. Middle tibiae (as usual) without the serration of small spines.

Length: about 1.5 mm.

Holotype male and allotype female: from upper Olaa Forest, Hawaii, July, 1953 (D. E. Hardy). Eight paratypes (four males and four females) from the following localities: same as type; N. slope of Hualalai, Hawaii, 4,000–6,000 ft., July, 1953 (D. E. Hardy); Kulani, Hawaii, 5,200 ft., July–August, 1952 and 1953 (D. E. Hardy and W. C. Mitchell); Keauhou Ranch, Kilauea, Hawaii, July, 1953 (D. E. Hardy); and Alakai Swamp, Kauai, 4,000 ft., July, 1952. I have also taken this species at Napau Crater, Hawaii, July, 1953, and one of the specimens in the series studied by Collin, but which was broken in shipment, was from Puu Kolekole, Molokai, July, 1952 (D. E. Hardy).

Type and allotype in the B. P. Bishop Museum. Paratypes in the following collections: U.S. National Museum; J. E. Collin collection, Newmarket, England; Hawaiian Sugar Planters' Association, and the University of Hawaii.

Species of *Chersodromia* normally inhabit the seacoast, and the above new species appears to be unique in occurring on the ground litter in treefern jungles in the wet rain forests in the mountains. The other Hawaiian species of *Chersodromia* (*C. hawaiiensis* Mel.) is found about the excavation holes of crabs on the beaches of Oahu and has the normal two pairs of vertical bristles on front, a quite small male hypopygium, shorter wings, and third costal section more thickened. The only other species with only one pair of vertical bristles are the European *C. difficilis* Lndbk. (a species otherwise very similar to *C. cursetans* Zett.), and *C. gratiosa* Beck. from the Canary Islands. The above new species is quite distinct from either of these, and the absence of the usual second pair of vertical bristles in these three species does not appear to be correlated with any other character of group importance.

Chersodromia hawaiiensis Melander (figs. 118d–g).

Chersodromia sp. Williams, 1937, Proc. Haw. Ent. Soc. 9:364.

Chersodromia hawaiiensis Melander, 1938, Proc. Haw. Ent. Soc. 10:57.

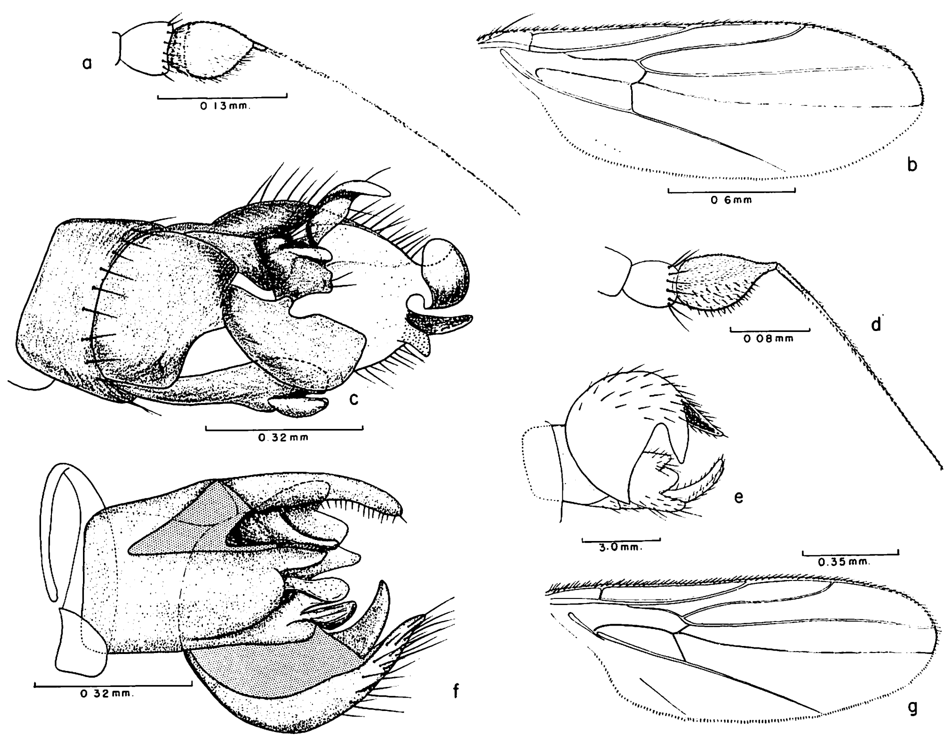

Figure 118—*Chersodromia dissita* Collin n.sp.: **a,** antenna; **b,** wing; **c,** male genitalia, dorsal view (aedeagus omitted). *C. hawaiiensis* Melander: **d,** antenna; **e,** male genitalia, ventral view; **f,** male genitalia, dorsal view; **g,** wing.

Endemic. Oahu (type locality: Hanauma Bay). Associated with crab holes on the beaches. I have also collected it on beach debris containing seaweed, dead fish, and crabs.

Type in the collection of Dr. A. L. Melander, Riverside, California.

Melander says this keys to *Chersodromia beckeri* Melander, from Europe (1927: 296), and differs by having the hairs and bristles of head and thorax black, the sternopleura pollinose, and the wing veins darkened. It is readily distinguished from the only other known species of this genus in Hawaii by the predominantly brown to black coloration, by the presence of two pairs of vertical bristles, and by the very differently developed, comparatively small, genitalia of the male (fig. 118f).

Head and thorax brown to black in ground color, rather densely grey pubescent. Antennae brownish yellow, apical arista about three times longer than third segment (fig. 118d). Proboscis about half as long as head and brownish yellow. Palpi yellow. Four pairs of dorsocentral bristles present, one presutural in position. Scutellum with four to six marginal bristles. Legs yellow, tinged with brown. Wings lightly fumose; venation as in figure 118g. Halteres pale yellow. Abdomen predominantly brown above, apices of terga yellow, also yellow on sides and venter. Genitalia of the male dark brown to black, rather small and inconspicuous (figs. 118e and f), densely grey pubescent, not quite as long as the last two abdominal segments.

Length: body and wings, 1.5–1.8 mm.

Genus **CROSSOPALPUS** Bigot

Crossopalpus Bigot, 1857, Ann. Soc. Ent. France (3) 5:557, 563.
Grossopalpus Scudder, 1882, Nomenclator, 149.
Eudrapetis Melander, 1918, Ann. Ent. Soc. Amer. 11:187.

Crossopalpus has been rather commonly treated in the literature as a subgenus of *Drapetis* Meigen (see Collin 1926:147). It is distinguished from *Drapetis sens. str.* by having the genae well developed, rather than the eyes extending downward almost to the oral margin; by having only one pair of ocellar bristles, rather than two; by the tibiae possessing spurs, rather than not having spurs; and by having each mesopleuron bare or nearly so, not with short hairs on the upper hind corner. Collin more recently (in correspondence) considers this a distinct genus. Engel (1939:108) treated it as a subgenus.

The *Drapetis sens. lat.* are distinguished from other members of the subfamily Tachydromiinae by having the thorax as wide as long, cell R much shorter than M, the anal vein and cell Cu absent, and the mesonotum and legs without strong bristles (except for the apical bristles on tibiae).

Only one species is known from Hawaii.

Type of genus: *Platypalpus ambiguua* Macquart.

Crossopalpus insularis (Melander) n. comb. (figs. 119a–d).
Drapetis (*Crossopalpus*) *insularis* Melander, 1952, Proc. Haw. Ent. Soc. 14:419.

Oahu (type locality: Honolulu). This is very probably an immigrant; it was first reported in November, 1951 (see Hardy 1952:453) and in Hawaii has been taken only at the dairy farm of the University of Hawaii campus. It is found flying in swarms of *Milichiella lacteipennis* (Loew) over compost. One specimen has been seen from Tutuila, Samoa, July, 1953, collected at dairy over manure (C. P. Hoyt).

Type in the U.S. National Museum.

This is a dark-legged species belonging in the *aenescens* group because it has a distinct lappet at apex of hind tibia and because the hind tibia lacks long extensor bristles. There is some controversy in the literature regarding the indentity of *C. aenescens* (Wiedemann). According to Melander (1952:420), the hind tibia is without a cluster of apical bristles in *aenescens*. According to Engel (1939:110) and J. E. Collin (in correspondence), *aenescens* does have these bristles at the end of hind tibia and it is uncertain just what *aenescens* of Melander might be. *C. insularis* apparently would actually fit very close to the true *aenescens* and from Engel's description of this species would appear to differ by having a pair of tiny, inconspicuous presutural and four pairs of postsutural dorsocentral bristles (not one plus two); by lacking posthumeral bristles; by having two long and four short bristles on scutellum (not two and two); and by the male genitalia being rather small and inconspicuous, not moderately large. In Melander's key (1952:

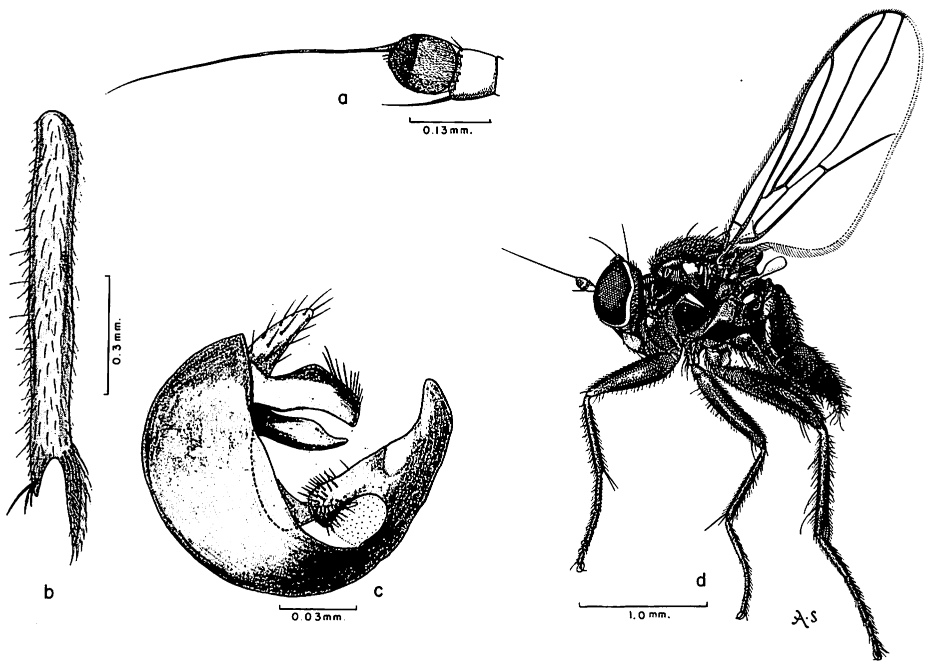

Figure 119—*Crossopalpus insularis* (Melander): **a,** antenna; **b,** hind tibia; **c,** male genitalia, lateroventral view; **d,** adult female.

420) it allies most closely with "*aterrima* Curtis," but as pointed out by Collin (1926:147), *aterrima* Curtis is a synonym of *curvipes* Meigen. Collin (in correspondence) says the species Melander lists under Curtis' name is actually *nigritella* Zetterstedt and differs by having two long flexor bristles on the hind tibia rather than without long bristles; by having small dorsocentrals, rather than lacking these bristles; and by having the halteres pale, rather than dark. Melander says *C. insularis* differs from other known Pacific species by its dark-colored legs.

Entirely shining black, metallic black on sides, rather thickly yellow pilose over body and legs (fig. 119d). One pair of ocellar and one pair of vertical bristles present on the head and a posthumeral bristle on thorax. Antennae dark colored,

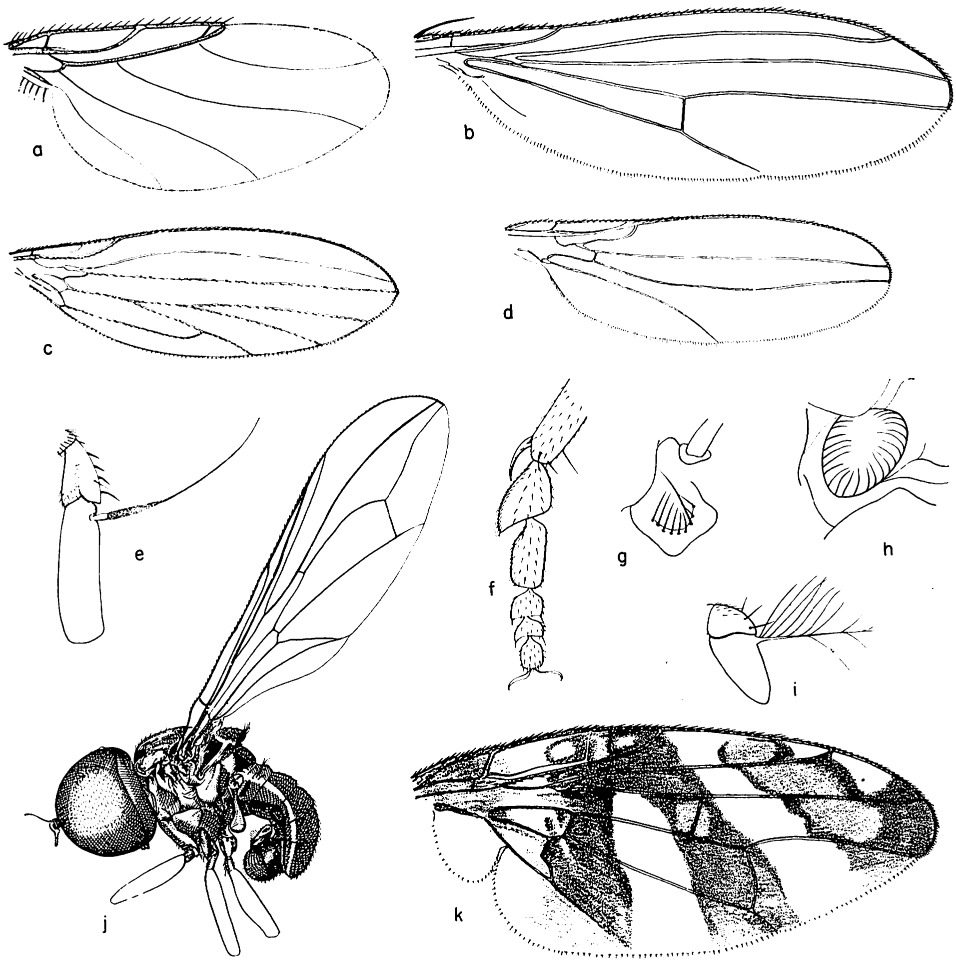

Figure 120—**a,** Wing, Phoridae; **b,** wing, Dolichopodidae; **c,** wing, Lonchopteridae; **d,** wing, Asteiidae; **e,** calypterate antenna showing cleft on second segment; **f,** hind tarsus of a Sphaeroceridae; **g,** metathoracic spiracle of Sepsidae; **h,** metathoracic spiracle of other acalypterates; **i,** antenna of a Drosophilidae; **j,** male Pipunculidae; **k,** wing, Tephritidae.

shaped as in figure 119a. Wing venation as in figure 119d. Cell R_5 slightly expanded at apical three-fourths. The lappet at apex of hind tibia shaped as in figure 119b. Male genitalia comparatively small, rather smooth, highly polished, evenly rounded on left side, and with a shallow concavity at apex which extends around the right side (fig. 119c). See original for more complete description.

Length: body and wing, 2.5 mm.

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